UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 868

Contribution from the Bureau of Biological Survey
E. W. NELSON, Chief

Washington, D. C. PROFESSIONAL PAPER January 10, 1921

# ECONOMIC VALUE OF THE STARLING IN THE UNITED STATES

By

E. R. KALMBACH and I. N. GABRIELSON
Assistant Biologists

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PLUMAGES OF STARLINGS.

Adult male (spring).

Adult female (spring).

Young in juvenal plumage.

Adult, male and female (fall).

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## PROBLEMS RAISED BY THE STARLING.

MINDFUL of the disastrous results that have attended the introduction of exotic forms of wild animal life, farmers and bird lovers generally have looked with apprehension on the introduction and spread of the European starling in the United States. When the destructive careers of such introduced forms as the brown rat, the house mouse, and the English sparrow are considered, not to mention the annual toll in millions of dollars now being paid to satisfy the appetites of numerous insect pests that have been unwittingly brought from abroad, it is not to be wondered at that the deliberate importation and liberation of a considerable number of another species of bird that has since increased enormously in numbers should produce discussion.

Criticism came first only from those who foresaw in the light of previous experiences what might be the result of an unhampered spread of the starling. For a number of years the birds were confined to a small area about the place of importation, New York City, and there they were of interest chiefly to ornithologists. Their spread, however, in the early years of this century to the neighboring suburban and farming sections of New York, New Jersey, and Connecticut brought them more intimately in competition with our native birds and in close contact with growing crops. The starling was heard from immediately. Reports of its aggressive tactics against native birds became frequent: Flicker nests were said to be usurped by the wholesale; the houses of bluebirds and wrens were sharing a similar fate; young robins were being dragged from their nests and killed; and the food supply of certain native birds was being seriously reduced by the ever-increasing flocks of the foreigner. From farmers, too, came criticism: Cherries, berries, apples, and pears were reported damaged; in spring garden truck suffered; and in midsummer sweet corn was attacked by the birds. Even from the cities came complaints of the noise and filth connected with the large roosts of late summer and fall, established usually in a residential section. Few indeed had a good word to say for the newcomer. The occasional words of praise, however, were significant. Coming usually from careful observers, these appeared to indicate that, despite its bad points, the starling was destroying terrestrial insect pests at a rate surpassed by few, if any, of our native birds.

From such conflicting testimony it was apparent that an accurate estimate of the starling's worth could be secured only by extensive field observation, supplemented by careful laboratory examination of the contents of a large number of stomachs collected under diverse conditions and representative of every month in the year. It was imperative that this be done in order that an intelligent attitude might be reflected in legislation enacted for the bird's protection or control. Such work the Bureau of Biological Survey began in the spring of 1916, and the results of its investigation are discussed in the following pages.

## SOURCES OF INFORMATION.

In conducting field work it was planned to visit as many points in the six States in which the starling was common in 1916 as one season's work by two investigators would permit.[1] Effort was

[1] Field work in the States of Connecticut, Rhode Island, and Massachusetts, as well as on Long Island, New York, was conducted by I. N. Gabrielson; and in Pennsylvania, New Jersey, and New York (except Long Island), by E. R. Kalmbach. This involved continuous observation from the beginning of April to the middle of October, a period in which all forms of damage of which the starling had been accused could be investigated. The authors collaborated in the examination of the material collected and in the preparation of the manuscript.

made to visit places from which complaints had come, and enough of these were investigated to give a good idea of the habits of the starling in areas where it had acquired an unfavorable reputation.

There were secured for this investigation a total of 2,466 well-filled stomachs, probably a greater number than has ever before been used for investigating the food habits of a single species of bird. Of these, 309 were of nestlings. Approximately two-thirds of the material was collected by representatives of the Biological Survey, the remainder being secured from reliable collectors, who at the same time submitted many economic notes of interest. Of these stomachs 1,250 were collected in Connecticut, 814 in New Jersey, 269 in New York, 62 in Pennsylvania, 43 in Massachusetts, 27 in Rhode Island, and 1 in Delaware. Besides these there were gathered 160 additional stomachs only partially filled with food. While these were not suited for estimating percentages, they furnished considerable information concerning food items.

In response to a circular letter sent under date of June 15, 1915, to numerous bird students, horticulturists, and practical farmers, 269 replies were received. The following questions, embodied in that circular, will give an idea of the data obtained:

1. About what year did the starling appear in your neighborhood?
2. Is it now common? When did it become so? Abundance as compared with other species.
3. Is the bird destructive to fruits? State kinds and, if possible, the approximate amount of damage.
4. Does the starling damage any other crops or property?
5. What are the relations of the starling to other birds?
6. Where plenty of nest boxes have been placed, has friction between the starling and other species decreased?
7. At what time of year do starlings begin to flock? Are they more destructive when in flocks than at other times?
8. Does the starling spend the winter in your locality?
9. From your observations do you consider the starling injurious or beneficial?

Besides the replies to these requests, correspondence from other sources has yielded many facts that have been incorporated in this bulletin.

## DISTRIBUTION AND ABUNDANCE OF THE STARLING.[2]

The starling (*Sturnus vulgaris*) is native to all but the most northern parts of Europe, and also occupies the same latitudes in the western two-thirds of Siberia. Migration in fall takes the bulk of the species to countries bordering on the Mediterranean, and a portion to the warm latitudes as far east as Hindustan. Several related species and subspecies of starlings occupy adjacent sections and even portions of the same areas in the southeastern part of this

[2] Most of the data here presented concerning the introduction and spread of the starling in the United States prior to 1916 have been compiled by W. L. McAtee, of the Bureau of Biological Survey.

range. The starling has been introduced and established as an integral part of the fauna of Australia, Tasmania, New Zealand, South Africa, and the United States.

In North America attempts have been made to establish it at Cincinnati, Ohio (1872, 1873); Quebec, Canada (1875); Central Park, New York City (1877, 1887, 1890, 1891); Portland, Oreg. (1889, 1892); Allegheny, Pa. (1897); Springfield, Mass. (1897); Bay Ridge, N. Y.; and a few other localities. The bird gained a foothold at Portland, but now is scarce or extinct in that vicinity. Apparently the introductions of 1890 and 1891 into Central Park, New York City, are the ones which resulted in the permanent establishment of the species, and from this colony have been derived the thousands of birds now scattered over the northeastern United States.

The starling has not spread with the rapidity characterizing the English sparrow's occupation of the country. One reason is that this bird apparently does not travel in box cars; another, that it has not been introduced into so many localities nor carried from place to place by man. Nevertheless, it has steadily widened its breeding range and each year performs more and more extensive migrations.

For six years after its first successful introduction into Central Park the starling did not breed beyond the limits of greater New York. In 1896 it was confined as a breeding species to New York City, Brooklyn, and Staten Island. By 1902 it had reached Norwalk, Conn., and Ossining, N. Y., on the north; and Bayonne, N. J., on the south. By 1906, territory as far north as Wethersfield, Conn., and as far southwest as Trevose, Pa., was occupied. In 1908, Providence, R. I., and Philadelphia marked the extremes of its breeding range; and by 1913, Hadley, Mass., and Westchester, Pa., had been reached. The bird bred not far from Washington, D. C., in the summer of 1916 and in the same season was found breeding as far north as the southern boundaries of New Hampshire and Vermont, while toward the northwest it had extended its breeding range as far as Oneida County, N. Y. (see map, fig. 1). In its post-breeding wanderings the starling has been recorded from a much greater area, extending in 1916 from southern Maine to Norfolk, Va. On November 10, 1917, one specimen was collected as far south as Savannah, Ga. Inland it has been seen at Rochester, N. Y., Wheeling, W. Va., and in east central Ohio.

As a breeder the starling is by no means uniformly distributed throughout its range. In the first place, it is decidedly partial to thickly settled agricultural sections. It shows also a preference for the vicinity of the coast and the larger river valleys, and in its spread over the country lowlands are populated first. In the strip of territory from New York City to New Haven, Conn., where the starling in 1916 seemed to be the most abundant breeding bird, it was con-

fined to a narrow belt of low, flat, or rolling farm land within 8 or 10 miles of salt water, and, with the exception of the Housatonic

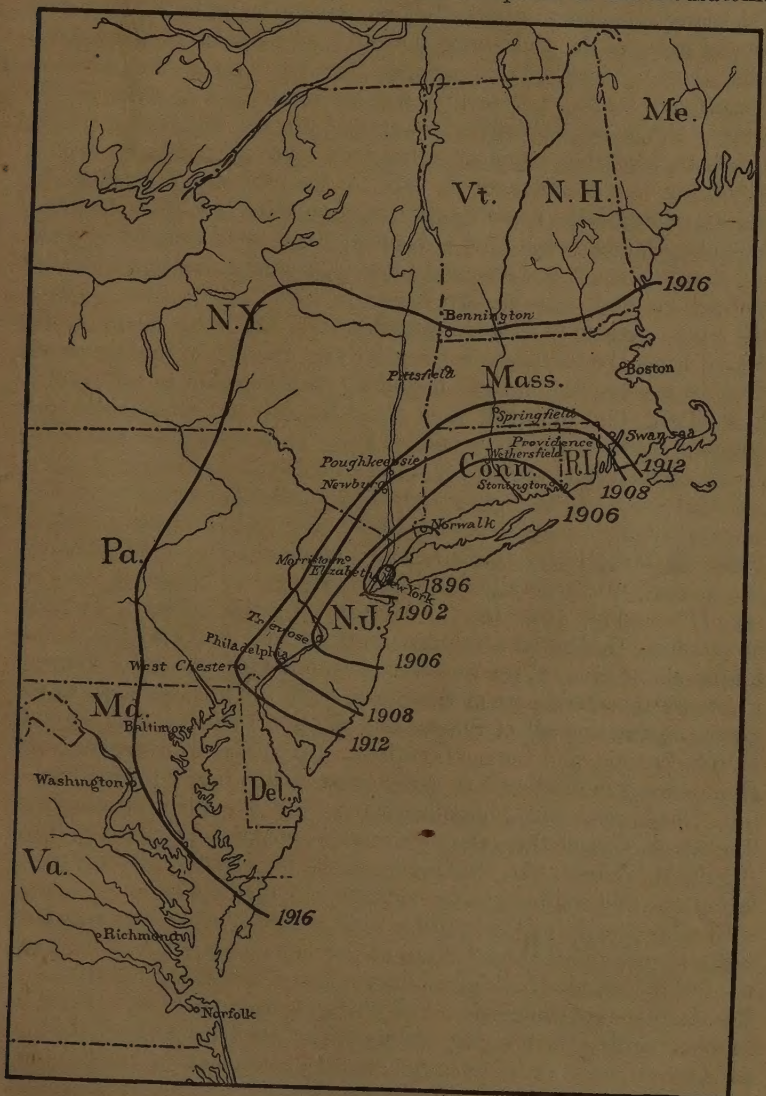


FIG. 1.—Breeding range of the starling at various periods from 1896 to 1916. Since 1916 this range has been extended so little that it is not indicated on the map.

Valley, there were few birds inland. East of New Haven the starling was restricted mainly to the shore. In most of the Con-

necticut River valley below Middletown, where it is narrow, with wild, rough land reaching often to the water's edge, the starling was scarce; but north of Middletown, where the valley widens until several miles of rich cultivated bottom land lie between the wooded hills, the bird was very abundant. Up the river as far north as Springfield, Mass., the starling was as common a breeder as the robin. North of Springfield it was not present in great numbers, although favorable conditions for food and nest sites prevailed. According to a count made in 1916 by the bird club of Springfield, that city contained a breeding starling population of 5,000. Amherst, Holyoke, Northampton, and Greenfield, Mass., had colonies of varying sizes, those of Amherst and Greenfield approximating 1,000 and 500, respectively. In eastern Massachusetts and in Rhode Island the birds were only local in distribution. On Long Island a line drawn from Oyster Bay on the north to Bay Shore on the south roughly marked the eastern boundary of the region of abundance. East of this line the birds were generally, but not abundantly, distributed on the north and south shores. They were absent from the center of the island except for a few in cultivated clearings.

In 1916, the starling was extremely abundant in northeastern New Jersey, where it had been established about the cities of Newark, Paterson, Montclair, Elizabeth, and Plainfield for at least 15 years. It was also quite generally distributed throughout Somerset, Middlesex, Hunterdon, and Mercer Counties. In the northern parts of Monmouth, Burlington, Camden, and Gloucester Counties it was locally abundant. There were very few, however, in the pine barrens in the southeastern part of the State, or in the hilly sections to the north, comprising all of Sussex and Warren Counties and parts of Morris, Passaic, and Bergen Counties. Up the Hudson the starling's abundance was restricted to the vicinity of the larger towns, Peekskill, Newburgh, and Poughkeepsie having the greatest numbers. The narrowness of the valley prevented a general distribution along the lower Hudson. In Pennsylvania the bulk of the starling population was still confined to the vicinity of Philadelphia.

The familiarity of the starling with human abodes, and the daily visits to a single feeding ground of the same post-breeding flock are the two factors that have given many persons an exaggerated idea of the abundance of the species. Few have attempted to estimate relative numbers during the breeding season. It is believed that in all of Hudson County, most of Essex and Union Counties, and the southeastern and southern parts, respectively, of Passaic and Bergen Counties, New Jersey, the starling in 1916 had reached a state of maximum abundance, beyond which it will not increase as a breeder. The same may be said of the area immediately to the east and northeast of Brooklyn and New York City and extending along the Connecticut

shore as far as Bridgeport. It is possible, of course, for the size of post-breeding roosts and winter flocks to be further augmented in this section by an increased breeding population in adjacent country. Taking this area as a whole, the starling about equaled the English sparrow as a breeder. In the residential sections of some of the cities it outnumbered the sparrow, but it in turn was greatly outnumbered about the freight yards, markets, business streets, and dumping grounds; and even in many of the rural sections the sparrow predominated.

Beyond this area of maximum abundance, centers of starling population, where the starling as much as equaled the English sparrow as a breeder, were quite restricted and often isolated from other colonies by many miles. Consequently, exaggerated ideas regarding the average abundance of the starling throughout its range were also held by persons living in the vicinity of localized colonies. A distance of but a few miles will at times reveal great differences in starling abundance. At Bernardsville, N. J. (July 22–25), starlings were too scarce to make collecting profitable, although at Mendham, only 6 miles to the north, the brood of the year was so abundant about the farms close to the village that the birds inflicted severe damage to the cherry crop. At Somerville, N. J. (June 5–8), only 10 miles from Plainfield, a center of starling population, the same unfavorable collecting conditions were met. At Freehold, N. J. (September 18–October 1), the location of a roost in the town accounted for an unusual abundance of starlings on the near-by farms, especially in early morning and late afternoon. After the roost had been eradicated, the starling could not be placed any higher than tenth in a list of birds of the surrounding country, arranged according to their abundance.

In 1916, there was a vast area along the borders of the starling's range where the bird was too scarce to be of any great economic significance. This applied to most of Massachusetts and Rhode Island; New York, north and west of Kingston; Pennsylvania and Delaware, outside of a 30-mile radius of Philadelphia; and New Jersey, south of a line drawn from Salem to Toms River. In this region many farmers were wholly unacquainted with the bird and very few had complaints to make.

With a knowledge of the starling's habitat and food preferences, both in Europe and in this country, and of the bird's ability to adapt itself to new environment, some conjecture may be ventured as to its ultimate distribution in the United States. Until 1916, the Allegheny Mountains appeared to be an effective barrier against progress to the west, but now that numbers have been reported at points west of the divide, the spread through the low, fertile farm land of Ohio and Indiana may be rapid. There appears no reason why

the starling, once established in the Mississippi Valley, should not readily extend its range as far north as the middle of Michigan, Wisconsin, and Minnesota. To the south, it will probably go nearly, if not actually, to the Gulf coast, though it may always be scarce as a breeder in the southern part of this area. To the west, the Great Plains with their scarcity of suitable nesting sites, and back of them the Rocky Mountains with their high altitudes, will bar the starling for many years from reaching the Great Basin or California by either a northern or a southern route.

## DESCRIPTION OF THE STARLING.

Even in areas where the starling has been long established uncertainty exists as to its identification. Post-breeding flocks of red-winged blackbirds are often called starlings, and the damage they do is often attributed to the latter. The great differences between the plumages of the young and of the adults, as well as the great change in the appearance of the old birds from fall to spring, also lead to confusion. The starling, however, bears several conspicuous marks of identification, and when these are borne in mind, one will have little trouble in recognizing the bird.

The adult starling is about 8½ inches long, and its weight is about equal to that of the robin; but its short, drooping tail gives it, when at rest, a chunky, humpbacked appearance. From early spring until the middle of June the adult bird may be singled out at a distance by its being our only black bird having a rather long, sharp, yellow bill. In the male the base of the lower mandible is somewhat darkened with livid; in the female these parts are simply paler yellow. After the breeding season, and coincident with the molt, the entire bill darkens until it is nearly black. The molt is usually completed by the middle of September and leaves the starling a much changed bird. The feathers of the sides of the head, breast, flanks, and underparts have white tips, so that from a distance the bird has a gray, mottled appearance. At close range, however, the starling is a handsome bird in this plumage; the dark parts of the feathers of the throat, breast, and flanks are resplendent with iridescent reflections of purple, green, and blue; while on the back, with its green and bronze iridescence, the feathers are tipped with brown. The tail and wings are dark, some of the feathers of the latter being edged with brown. During winter most of the white tips to the feathers on the breast and underparts wear off, leaving the bird dark below, with the iridescent reflections still present. (See frontispiece.)

On leaving the nest the young are a uniform dark olive-brown on the back, and below they are at first somewhat streaked with lighter markings, but soon become unicolor; the throat is white or buffy. The first molt begins about the same time as that of the adults.

The first new feathers appear on the sides of the breast, the flanks, and the center of the back, while the plumage of the head is the last to change. During July, August, and early September, young birds in all stages of the molt may be found. When the plumage has completely changed the young can not with certainty be distinguished from the adults, although they tend to have larger white tips to the feathers below.

In flight the starling may be confused with a few other species. From its habit of sailing on fixed wings for considerable distances it is often mistaken for the purple martin, but a little watching will reveal the starling's greater speed. When in flocks starlings may be distinguished from other gregarious species with which they often associate by the wonderful coordination of action between the individuals of the flock, their rapid wing beats, great speed, and ability to alter direction instantly.

In searching for food the starling walks rather rapidly and with little change in pace, keeping up a continuous zigzag course when on grassland, seldom hesitating unless to pick up food.

The contention of many bird lovers that the starling's lack of song is a good reason for not allowing it to supplant native songsters is open to controversy. While its notes, outside of a clear whistle or two and a coarse rasping note of alarm, are subdued and lack melody, should one chance to be close to a male starling putting forth his best efforts, the results will be as fascinating as the more celebrated whisper songs of the catbird or of the brown thrasher. The starling is a mimic par excellence and has the notes of a number of our native birds already in its repertoire, a fact that has often led to error in identification when the observer placed too much confidence in notes alone. Perhaps the bird most frequently imitated is the wood pewee, whose plaintive "pee-a-wee" is reproduced with such delicate skill that it can not be distinguished from the song of the woodland flycatcher itself. The mellow tones of the bluebird's call are given with almost equal fineness. In areas where the bob-white is common its two-noted whistle is readily taken up by the starling and executed in a way that closely resembles the original. Notes of the red-winged blackbird, grackle, field sparrow, flicker, blue jay, Carolina wren, and English sparrow also are given, but less frequently. Young starlings have a harsh, hissing, or rasping note, which seems to have its origin as a feeding call, but is given for some time after leaving the nest.

## LIFE HISTORY.

During the first week in April the wintering flocks of starlings begin to decrease in numbers as the birds mate and wander off in

search of nesting sites. By the middle of the month this process is completed, although the birds often return to the old roosts for the night until nest building is started.

For nesting sites, old woodpecker holes, natural cavities in trees, bird houses (particularly those intended for bluebirds, flickers, and martins), and cornices or crevices about buildings are most frequently chosen, although nests have been found on fire escapes, hay tracks, and barn doors, behind window shutters, and even in open boxes erected for pigeons. In fact, any cavity, regardless of size of opening or depth, may be utilized if the starling is able to enter it at all. The nesting sites chosen are frequently poorly protected from rain; consequently the nests are foul and damp.

In the mere construction and occupancy of their nests, starlings have been the source of some complaint. Being sturdy birds and equipped with bills well suited for tearing things to pieces, though not especially adapted to chiseling healthy wood, they will at times do damage to roofs not recently shingled. The clogging of hay tracks or tracks of barn doors with their nests is occasionally a source of trouble, and the infesting of the immediate vicinity of their homes with bird lice is complained of when they build about water tanks, poultry houses, etc. The filthiness of their nests, due to the great quantity of excreta deposited, is also a common complaint, especially when the birds choose some spot immediately above the doorstep for their breeding operations. This condition prevails most often during the latter stages of the nestling life, when the parent birds are unable to remove all the accumulation.

The height at which starlings nest is variable, the lowest nest cavity observed being 2 feet from the ground and the highest fully 40 feet. When they nest in trees the cavities usually range from 10 to 25 feet from the ground.

The nest itself is usually composed almost entirely of dry grasses and is sufficiently large to fill the bottom of a cavity 3 to 4 inches deep. The interior of the nest will approximate 3 inches in diameter. A little green foliage, usually a few leaves taken from a near-by branch, is dispersed throughout the grassy structure. The interior is lined sparingly with feathers of domestic fowls. Straw, corn husks, string, and cloth are other materials sometimes used in nest building. Nesting sites used for several years in succession gradually fill up with a partly decayed mass of these materials. From one nest in the cornice of a sawmill a good half bushel of material was removed.

The eggs are of a pale-blue color and number from 3 to 6 to the set. Incubation lasts about 12 days. The young remain in the nest from 2 to 3 weeks, or until they are able to fly, which they do well on their first attempt. This habit, combined with the protected nest

sites, tends to reduce the mortality among young starlings much below that of many other species.

Nestling starlings are fed by the parents largely on insects. For the first week both parents take part in the feeding operations, but in several nests that were under observation the female was left to do all the work during the later part of the nestling period. When 3 or 4 days old the young are very noisy and give the feeding call in lusty chorus in response to almost any sound. Later, they learn to distinguish the approach of the parents and respond only to their notes or appearance. Other noises or vibrations cause them to crouch silently in the bottom of the nest, and no amount of coaxing will persuade one of them to stir or make a sound.

Two broods are usually raised each year and sometimes there are three. The first of these leaves the nest about June 1 and the second late in July. Fledglings which may have been from either a belated second or third brood just from the nest were collected as late as September 12, at Bay Shore, N. Y.

As soon as the first brood leaves the nest small flocks of young starlings can be found feeding on grasslands or roosting at night in trees or buildings. These flocks grow rapidly in size and by mid-July often number into the thousands. During the day no adult birds are found in these early flocks and very few appear until after the completion of the molt in September; both old and young, however, occupy the same nightly roost. These post-breeding flocks usually select a roosting place in trees in the residential sections of cities and are there the cause of much complaint. Occasionally a roost will be formed in a cat-tail marsh or in a building, but this is the exception rather than the rule.

At a roost in a marsh along the Hackensack River an opportunity was afforded to watch the starlings congregating. As early as 3 o'clock in the afternoon flocks of a dozen or two could be found gathering in the hayfields in the vicinity, or perching on dead chestnuts, singing and preening their feathers. Most of these were juveniles with the molt extending up as far as the neck. They would fly alternately to the hay stubble, which was heavily infested with grasshoppers, and then to the tree tops when flushed. By 4 o'clock a flock of a hundred or more had gathered. In the scramble for grasshoppers and crickets, one or more momentary conflicts between competitors would be almost continuously in progress and, as the flock progressed across the field, a rolling aspect was imparted to it as birds in the rear would fly forward to new territory.

With the approach of evening the birds would rise and perform numerous flight evolutions, in which they displayed wonderful coordination of action. This was best observed when they would fly in the direction of the sun, and the flashes of light coming from

their glossy backs appeared as coming from a single mirror instead of from several hundred bodies acting independently but in perfect unison. After a minute or two of such flight the flock would sometimes seem suddenly to lose this ability of coordinated action and the individuals would spread out in a long wavering line, breaking up into several groups before alighting. As dusk approached, the birds had worked their way toward the Hackensack River, where they gathered in compact flocks, singing in the tree tops along the bank. (Pl. II.) A few were seen feeding with a large number of red-wings on the tidal flats along the edge of the marsh. When darkness finally came the starlings in the tree tops sailed out over the marsh and joined their relatives, perching on the cat-tail flags for the night.

The behavior of starlings at all other roosts which came under observation was much the same, except in one instance, at Glenn Cove, N. Y. Here the birds went through the usual maneuvers and settled in company with a great number of grackles in a grove on the outskirts of town. Late in the evening the entire flock rose in a body and flew to the permanent roost half a mile or more away, behaving much the same as do crows in gathering at a winter roost.

These summer roosts are often inhabited by several species. Grackles or starlings usually form the bulk of the occupants, but there may be also numbers of cowbirds, red-winged blackbirds, English sparrows, and robins. An unusual roost was established at Washington, D. C., in August, 1917. At a point on the Mall, where grackles had roosted for years and starlings had been found for several seasons, a great mixed flock congregated, consisting of 8,000 or more purple martins, about 1,000 grackles, 300 starlings, and a few swallows (probably rough-winged swallows).

The birds from these summer roosts frequently have a definite feeding route. For example, the starlings from the Glenn Cove roost flew south and east for about a mile to commence feeding, and from 5 to 7 o'clock each morning could be found in almost the same locality—an abandoned field. From here they worked in a well-defined circle, appearing at 4 o'clock in the afternoon in an orchard three-quarters of a mile north of the roost and feeding there and in the surrounding fields until going to the trees for the night.

In October or November the starlings voluntarily abandon these tree roosts and resort to church towers, barns, or other buildings for shelter. Here they gather nightly until spring, when the flocks are broken up by the mating impulse. A local estimate of the number of birds in such a roost in a church tower in Norwalk, Conn., varied from 10,000 to "a million," but an approximate count revealed the fact that not more than 1,000 birds were roosting there in April, 1916.

Although the starling remains in some numbers throughout the breeding range during the winter, it exhibits a certain migratory

STARLINGS AT HACKENSACK, N J., ROOST.

Photograph taken at about sundown while most of the birds were singing. A few moments later these starlings, along with hundreds of others, sailed out over a near-by marsh, where they roosted among cat-tails in company with many red-winged blackbirds.

movement. All the birds in one locality collect into a single roost, but in addition to this there is a large increase in the flocks along the seacoast and a considerable movement southward from the breeding area. For three years a varying number of starlings appeared in a fall roost in Washington, D. C., before breeding birds were first found in 1917. Other localities south of the breeding range have also reported wintering flocks for several years before the birds have become permanent residents.

## ECONOMIC STATUS IN OTHER COUNTRIES.[3]

While the behavior of the starling in its native home and in countries to which it has been introduced can not be interpreted as a certain indication of its conduct under the new conditions it will meet in this country, its activities elsewhere will serve to call attention to its capabilities for doing good or harm. Throughout most of its breeding range in Europe, particularly in France, Germany, and Hungary, the bird is held in great esteem and is encouraged, by the erection of nest boxes, to breed about farms and gardens.

The chief German authorities, with one exception, have considered the starling more beneficial than injurious. The birds there do considerable damage to grapes and cherries, and to a smaller extent injure various cultivated berries. On the other hand, they feed freely upon injurious snails and slugs, beetle larvæ, caterpillars, maggots, and grasshoppers. Among their prey are such pests as ticks, gadflies, stable flies, cockchafers, fern beetles, pine weevils, fir weevils, spruce moths, and field and mole crickets.

French authors mention damage by the starling to olives and grapes, but are unanimous in declaring the species useful. It is significant, moreover, that, although one of their articles was published in a viticultural journal, damage to grapes, one of the greatest points made against the starling, was not considered sufficient to exclude the bird from the list of useful species.

In Belgium the starling is said to be very useful and its damage insignificant, as it prefers an insect diet. It eats about the same pests as in Germany, and in addition wireworms, grass moths, plant lice, and oak leaf-rollers.

The late Otto Herman, distinguished Hungarian ornithologist, asserts[4] that, taking its feeding habits of the whole year into consideration, the starling does a thousand times more good than harm and richly deserves protection. Starlings have rendered particularly efficient service during locust plagues in Hungary.

The single Swiss author consulted gives the bird about as much adverse criticism as praise; and a communication from Tunis states

[3] The data presented under this topic were compiled by W. L. McAtee, of the Biological Survey.

[4] Herman, Otto, Nutzen und Schaden der Vögel, Leipzig, p. 181, 1903.

that on isolated plantations migrating starlings sometimes take the entire olive crop.

In 13 of 18 general articles on the starling in Great Britain it is stated that the bird is more beneficial than injurious; one article says that while the bird is valuable now, its habits are undergoing a change for the worse, and four state that although very useful in grasslands and forests, the starling is entirely too numerous for the best interests of fruit growers. Exhaustive investigations of the bird's habits have been made by Gilmour, Newstead, Collinge, and the national board of agriculture. After reviewing the whole question of the starling's economic status the board of agriculture concludes[5] that "on the whole * * * the information at present collected goes to show that, in view of their great partiality for insect food, starlings are, from the forest standpoint, entirely useful, whilst in agriculture and gardening their usefulness far more than outweighs the occasional harm done."

Summing up, it may be said that in Europe the verdict on the starling is distinctly favorable; of 35 works dealing in a general way with the economic status of the bird, only 7 report adversely. It is noteworthy, moreover, that the findings of all the thorough and more scientific investigators have been in favor of the species, although some authors admit that at present starlings are too numerous in some localities.

In most countries where the bird has been introduced, the case is different. In Australia and Tasmania testimony concerning starlings is generally unfavorable. Their great faults are driving away native birds and preying upon fruits. They have by no means lost their insectivorous tastes in their new home; in fact, they are credited with suppressing plagues of grubs and crickets which destroy grain and grass. Their numbers have become so great, however, that after the breeding season enormous flocks band together and at times descend upon orchards, vineyards, or gardens, where they make great havoc with the crops.

The introduction of the starling into New Zealand does not seem to have resulted so unfavorably as in Australia. In 1907, just 40 years after the first importation, James Drummond published an account of the activities of the species in that country.[6] His conclusions were based on the testimony submitted by many farmers who had experience with the birds, and were to the effect that the starling was one of the most valuable of insectivorous birds.

[5] Board Agr. and Fisheries (London), Leaflet 45, Rev. ed., 4 p., June, 1905.
[6] New Zealand Dept. Agr., Div. Biol. and Hort., Bull. 16, 1907.

## FOOD HABITS IN THE UNITED STATES.[7]

Examination of 2,157 stomachs of adult starlings[8] showed that 57 per cent of the annual food was animal and 43 per cent vegetable. During the months from April to November, inclusive, excepting July, animal matter made up more than half the food, the maximum being taken in April and May (91.22 per cent and 94.95 per cent, respectively). In July, with the great abundance of mulberries and cherries offering an unlimited supply of luscious fruit, of the 52.67 per cent vegetable matter taken, nearly all, or 50.74 per cent of the total, consisted of these two items. In February, animal food dropped to the lowest point in the year, 28.17 per cent. The average, however, for the four winter months from December to March was 31.5 per cent, a remarkable showing when circumstances are considered. The great majority of these winter stomachs were collected in New Jersey and Connecticut, and in view of the usual climatic conditions in these two States it seems noteworthy that starlings were able to secure such a relatively high proportion of animal food.

### ANIMAL FOOD OF ADULTS.

#### INSECTS.

Of the total yearly food of the adult starling, 41.55 per cent is composed of insects, a greater proportion than is shown in the food of most of our native birds of similar habits. The monthly percentages of insect food are as follows: January, 27.66; February, 23.81; March, 23.87; April, 32.61; May, 49.94; June, 52.26; July, 41.98; August, 56.92; September, 52.83; October, 57.8; November, 54.0; December, 25.2.

During winter many hibernating insects or the bodies of dead insects which have been preserved by the season's cold are eaten. Among these, beetles, weevils, stinkbugs, grasshoppers, caterpillars, and lepidopterous pupæ are conspicuous. As the fields become more thoroughly gleaned the percentage of insects eaten decreases, until in February and March it reaches its minimum, 23.81 per cent and 23.87 per cent, respectively. In April, as insects begin to appear in numbers, the percentage rises, and during the months from May to November, except in July, when the starling temporarily abandons an insect diet to feast on wild fruit, over half the total food is insects.

As the character of the insect food of a bird is of vast importance in fixing its economic status, the different groups of insects in the food of the starling will be taken up in the order of their importance.

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[7] Graphic summaries of the food habits of adult and young starlings are presented in figures 2 and 3 (p. 38 and p. 45, respectively); and the relative proportions of the various food elements are set forth in percentages in Tables II and III (p. 39 and p. 44, respectively).

[8] Included with the stomachs of the adult birds here discussed are stomachs of juvenile birds that had left the nest and were shifting for themselves.

It must be remembered that in ascertaining the economic worth of a bird not all the insects eaten can be placed to its credit, as many are of great value because of their predacious or parasitic habits.

### Coleoptera (Beetles).

Of the 41.55 per cent of insect food consumed by the starling, nearly half (19.59 per cent) consists of beetles. These are divided among numerous families, but weevils, carabids, and scarabæids, in the order named, are of the greatest importance.

The Rhynchophora, or weevils, stand first among the Coleoptera in the proportion of food furnished, 8.5 per cent of the starling's food being from this source. In feeding on this group the starling is doing a very useful work, as the snout beetles include some of the most destructive insects with which man has to deal. Weevils are eaten every month in the year. The smallest quantity taken in any one month was 3.13 per cent in October, and the largest, 20.16 per cent in a winter month, February. An examination of the monthly percentage table (p. 39) shows that there are two periods of the year in which weevils form over 10 per cent of the food. The first is in July (13.36 per cent) and August (10.91), when many species are emerging; and the second is in January (14.10) and February (20.16), when the starlings are feeding on hibernating forms.

One of the most interesting food habits of the starling is in its relation to the clover leaf weevil (*Hypera punctata*), a European insect which has long been introduced and acclimated in the United States and which does serious damage to the clover crop in some seasons. It is known that the starling habitually feeds on this insect in England, but it apparently goes far beyond its normal habit in feeding on it in this country. Nearly half (1,125) of the 2,301 adult birds examined had eaten clover leaf weevils, and 12 had taken their larvæ. Of these no less than 54 had taken 10 or more weevils for one meal and 106 had taken from 5 to 10 weevils. The largest number of larvæ eaten was 49, taken by a bird collected in New Jersey in May. These formed 38 per cent of the stomach contents. Twenty-six was the greatest number of adults from one stomach, and these, together with 6 other weevils, formed 95 per cent of the food. In February, 288 of the 398 stomachs examined contained remains of this beetle, and in January, 33 of 84. In July, 211 of 375 birds and in August, 216 of 347 had taken this weevil.

In every month of the year the starling is searching the grasslands and weed patches for the clover leaf weevil. The high percentage revealed in January and February would seem to indicate that *Hypera punctata* hibernates in far greater numbers than has been commonly believed, for it is scarcely conceivable that so many dead insects would be left in as good condition as are many of these this

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FIG. 1.—STOMACH CONTENTS OF JUVENILE STARLING.

Nearly 95 per cent of this bird's food consisted of the remains of 26 clover-leaf weevils, the heads, thoraces, and wing covers of which may be seen at the left of the picture. The large mass in the upper right-hand corner is additional débris of the same insects; below it are parts of a clover-root weevil; and in the lower right-hand corner are fragments of the skin of a cultivated cherry.

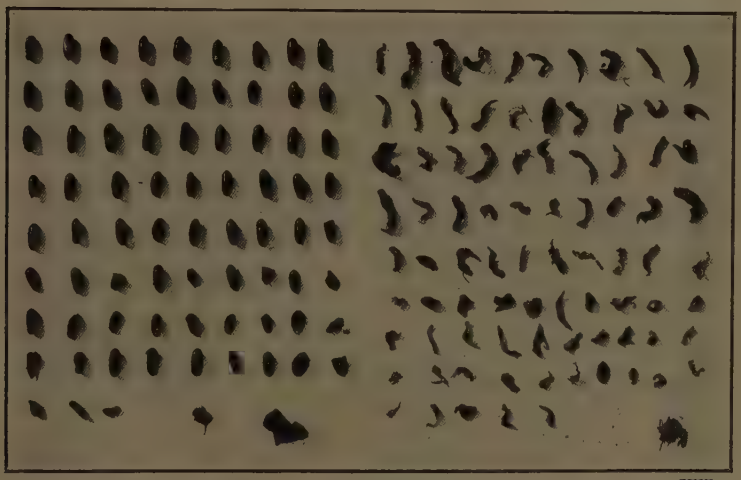

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FIG. 2.—STOMACH CONTENTS OF JUVENILE STARLING.

Except for a few bits of vegetable rubbish, shown in the extreme lower right-hand corner of the picture, all of this bird's food consisted of flies in one stage or another of development. There were present 1 adult and 76 puparia of Muscidae, at least 85 sarcophagid larvae, and another puparium. This bird apparently had been feeding in the vicinity of carrion or garbage.

late in winter. For example, one bird from Massachusetts in January had eaten 14 of these weevils and 4 others, which made a total of 26 per cent of its food. A Connecticut bird taken in the same month had also eaten 14 of these weevils, which formed 32 per cent of the food. In these two months 14 of the birds had taken more than 5 *Hypera* at a single meal. (Pl. III, fig. 1.)

Another weevil eaten in considerable numbers is the lesser clover leaf weevil (*Phytonomus nigrirostris*). Seventy-three of the 2,301 adult birds had fed on this insect. The greatest number taken was 9 by each of 2 birds. The clover root curculio (*Sitona hispidula*), the larvæ of which feed on the roots of various species of clover, is also a favorite article of diet, having been taken by 505 adult starlings. It was found most abundantly in the same months as the clover leaf weevil, as 27 of 84 birds taken in January, 119 of 398 taken in February, 83 of 375 in July, and 86 of 347 in August had eaten it. The birds frequently took numbers of this species, 36 having taken 5 or more. An August bird from Pennsylvania had eaten 30 adult clover root curculios, and one from New Jersey had taken 31. The closely related weevil *Sitona flavescens*, which has similar injurious habits, is preyed upon to a less extent, only 33 of the 2,301 adults having eaten it. One of these, however, taken in Connecticut during August, had devoured 17 of the weevils, and several others had taken 2 or more.

The strawberry crown girdler (*Otiorhynchus ovatus*), the larvæ of which feed on the roots of strawberries and other plants, had been eaten by 60 adult starlings, and the closely related weevil (*Otiorhynchus sulcatus*) known in Europe as the black-vine weevil, had been taken 7 times. *Barypeithes pellucidus*, another weevil known to attack strawberries and found in southern New England and adjacent States, had been taken by a single bird, which had made 75 per cent of its meal on 167 individuals.

In point of numbers taken, *Sphenophorus*, a group of destructive weevils known as billbugs, which bore into the seeds and stems of grain, stands next to the clover weevils, as at least 225 starlings had eaten them. Of these the "bluegrass billbug" (*S. parvulus*), which had been eaten by 104 birds, was most frequently taken. These insects sometimes do considerable damage to timothy. Five other species of this genus, all of them injurious, were taken in varying numbers by the birds. *Phyxelis rigidus* was found in 90 stomachs, one of which contained 13 individuals.

As the starling stomachs examined often contained several species of these injurious weevils, a few of the more interesting ones are mentioned here. In a July stomach from Pennsylvania 20 *Hypera punctata*, 14 *Sitona hispidula*, and 2 *Sphenophorus* sp. formed 95

per cent of the contents. A New Jersey bird taken in the same month had made 60 per cent of its meal on weevils, as follows: 3 *Hypera punctata*, 9 *Sitona hispidula*, 1 *Sitona flavescens*, 1 *Phytonomus nigrirostris*, 1 *Sphenophorus parvalus*, and fragments of one other weevil. An August bird taken in Connecticut had eaten 13 *Hypera punctata*, 3 *Phytonomus nigrirostris*, and 1 other weevil, making of these 72 per cent of its meal. Another bird from the same State collected in January had eaten 9 *Hypera punctata*, 2 *Sitona hispidula*, and 3 *Sphenophorus parvulus*, which formed 50 per cent of the total stomach contents.

From the foregoing data it is evident that the starling is a very effective enemy of such weevils as feed on grass or forage crops. This is particularly noticeable in regard to the clover pests, and it is safe to assert that *the starling is the most effective bird enemy of the clover weevil in America.*

It seems natural that the Carabidæ, or ground beetles, being to a large extent grass-inhabiting forms, should be present in the starling's food, of which they constitute 5.71 per cent. As this family contains both beneficial and injurious insects it will be necessary to consider it in some detail. During the months from April to October, inclusive, carabids furnish a considerable portion of the food, varying from 4.56 per cent in October to 13.02 in August. They are among the first beetles to appear in spring, and are promptly sought for by the starling. This is strikingly shown by their increase in the food from 1.07 per cent in March to 7.31 per cent in April. The maximum consumption of these insects is in August and September (13.02 per cent and 12.93 per cent, respectively, of the food). During the other months the number taken is small and in no case forms much more than 1 per cent.

Inasmuch as ground beetles seldom occur in nature in as great numbers as some of the plant-feeding beetles, their presence in starling stomachs is usually limited to a few individuals. They were found, however, in moderate numbers in nearly every stomach collected during the summer.

Comparatively few of the large predatory carabids of the genera *Carabus* and *Calosoma* are captured by the starling, as, of 2,301 birds, only 20 had eaten the former and 3 the latter. *Pterostichus*, a genus of small beetles living largely on animal matter, was found more frequently, 160 birds out of 2,301 having fed on it. One member of this genus, *P. lucublandus*, a medium-sized beetle, was found in 102 stomachs. Thirteen birds had captured members of the genus *Dicælus*, a highly beneficial group which feeds on insects, and 67 had eaten various species of *Platynus*, beetles with somewhat similar food habits. Ninety-five stomachs contained members of the genus

*Chlænius*, also insectivorous, and in 36 were the remains of *Casnonia pennsylvanica*, a curious and easily recognized little carabid.

By far the greater part of the carabids eaten by the starling are those that are known to be somewhat vegetarian in habits, notably certain members of the genera *Harpalus* and *Anisodactylus*. These beetles feed to a considerable extent on grass seeds and pollen and, therefore, can not be classed among the more beneficial carabids. Eight species of *Harpalus* were identified in the material examined, and in 277 stomachs the identification could be carried down only to the genus. *Harpalus caliginosus*, the largest member of the group, was identified in 144 stomachs, and *H. pennsylvanicus* in 79. One hundred and thirty-eight birds had eaten beetles referable to *Anisodactylus*, but these could not be specifically identified. Of the four species of this genus found in starling stomachs, *A. rusticus*, identified in 65, was the most common. Carabids of the genus *Amara*, that are to a considerable extent vegetarian in their feeding habits, were eaten by 151 of the starlings examined; *Scarites subterraneus* was found in 14 stomachs; and *Agonoderus pallipes*, which is injurious to sprouting corn, in 3.

When feeding heavily on carabids, the starling usually secures a number of species. For instance, a bird shot in New Jersey in April, that had made 91 per cent of its meal on carabids, had eaten 1 *Amara*, 1 *Anisodactylus*, 1 *Platynus cupripennis*, and 1 *Agonoderus*; while a June bird from the same State had taken 20 *Amara pennsylvanica* and at least 2 other carabids, these forming 75 per cent of the stomach contents. A July bird from Connecticut that had made 13 per cent of its meal on beetles of this family had varied the menu by taking 2 *Pterostichus lucublandus*, 1 *Bembidium quadrimaculatum*, 2 *Harpalus* sp., 2 *Anisodactylus rusticus*, and 1 other carabid. A New Jersey bird taken in the same month had devoured 19 *Amara*, 3 *Agonoderus*, 2 *Anisodactylus*, 11 *Harpalus*, and 2 other carabids, which totaled 84 per cent of the food. A Pennsylvania bird collected in August had eaten 1 *Harpalus caliginosus*, 2 *H. pennsylvanicus*, 10 *H. erythropus*, 5 *Pterostichus lucublandus*, 1 *Anisodactylus*, and 1 other carabid—items which formed 72 per cent of the stomach contents.

It must be admitted that in its fondness for terrestrial carabids the starling does some harm by consuming useful forms, but a study of the above data shows that only a small part of the Carabidæ eaten are of the decidedly beneficial species.

The scarabæids, or lamellicorn beetles, follow the weevils and carabids in the quantity of food furnished the starling, 2.24 per cent coming from this source. Of these by far the most important are the May beetles (*Phyllophaga*, adults of the notorious white grubs), which furnish the bulk of the 2.24 per cent. Both adults and larvæ are eaten, the former more frequently. No less than 11 species of

this genus were identified in the food of the starling, and from 4 to 8 individuals were frequently found in a single stomach. One bird collected in June had eaten 12. Approximately 300 of the 2,301 adults had taken May beetles, most of them in May, when they formed 11.04 per cent of the food. Dung beetles of the genera *Aphodius* and *Atænius* were commonly eaten, and *Canthon* and *Onthophagus* less frequently. Investigations conducted in 1919 to determine the bird enemies of the recently imported Japanese beetle (*Popillia japonica*) revealed the fact that the starling preys also on this insect; 2 of 6 starlings collected at Riverton, N. J., in August, had fed on it.

The Staphylinidæ (rove beetles), Chrysomelidæ (leaf beetles), Elateridæ (click beetles), Tenebrionidæ (darkling beetles), and others were taken in varying numbers. Most of these are small forms, and a considerable number could be destroyed without appreciably affecting the various percentages. Among the beetles of these families which were frequently eaten were many of economic interest, a few of which are here mentioned. *Drasterius elegans*, the larva of which is a wireworm that feeds on the roots of corn and other grains, had been eaten by 17 of the 2,301 adult starlings: *Agriotes mancus*, a species of similar habits, by 4; and *Colaspis brunnea*, a small leaf beetle that attacks beans, strawberries, and other cultivated plants, by 56.

Near Medford, N. J., it was stated that starlings had been seen working through a potato patch picking up potato beetles. Corroborative evidence was lent to this observation by finding the potato beetle (*Leptinotarsa decemlineata*) in the stomachs of 24 of 2,301 adult starlings and in 15 of 325 nestlings. Several birds had taken 4 individuals, while two nestlings had been fed 6 and 7, respectively. Many other chrysomelids, all of which are more or less harmful, are included in the food of the starling, the genera *Typophorus*, *Nodonota*, *Zygogramma*, *Calligrapha*, *Gallerucella*, *Oedionychis*, and *Chætocnema* appearing regularly, though in small numbers.

The only darkling beetle taken in numbers was *Opatrinus notus*, found in the stomachs of 82 adults. Aside from these, a long list of other beetles, a few beneficial but most of them injurious, were identified in small numbers. On the whole, it may be said that the evidence obtained by a study of the starling's destruction of Coleoptera is overwhelmingly in the bird's favor.

### Orthoptera (Grasshoppers, Crickets, and Locusts).

While grasshoppers are not the serious pest in the Eastern States that they sometimes become west of the Mississippi, they nevertheless exact a certain annual toil from crops. A conservative estimate

of the annual loss in this country due to the grasshoppers is $50,000,000.[9] This would be much greater were it not for the controlling influence of insectivorous birds. Some of these, among which may be placed the starling, secure practically all of their insect food during September and October from this source, stopping thereby the depredations of millions of these insects and preventing the future development of countless millions more.

Orthoptera, among which the shorthorned grasshoppers (Acrididæ) and crickets (Gryllidæ) predominated, constituted 12.41 per cent of the annual food of the adult starlings examined. August to November, inclusive, are the months of greatest consumption, the percentages being 22.30, 30.75, 38.95, and 38.26, respectively. December and January are represented by 4.76 and 4.42 per cent, while from February to July few Orthoptera are secured, a fact quite logically explained by the life history of the insect. The extent to which the adult starling resorts to this food is shown by the fact that of the 2,301 stomachs examined over 800 contained the remains of Orthoptera, and during the height of the grasshopper season, from August to November, inclusive, 577 of 772 birds had fed on them.

When hay fields are being cut and raked in the latter part of August and early in September, flocks of juvenile starlings secure practically all their sustenance from these insects, supplemented with wild black cherries (*Prunus serotina*) and elderberries (*Sambucus canadensis*). Of a series of 20 birds collected in one hayfield near West Englewood, N. J., 16 had fed on Orthoptera, including acridids and crickets of the genera *Gryllus* and *Nemobius*. Still more remarkable is a series of 138 stomachs collected from September 20 to September 28 in the vicinity of Freehold, N. J.: All but 9 of these contained grasshoppers or crickets, and in bulk the insects formed 24 per cent of the food. That Orthoptera are abundant and sought for faithfully in the cool days of October is shown by a series of 11 starlings secured near Meriden, Conn.: These insects had supplied food for all of these birds and formed the sole content of 5 stomachs, and in bulk formed over 85 per cent of the total food taken. These 11 birds had destroyed no less than 40 grasshoppers, 77 crickets, and 1 locustid; 24 of 25 starlings secured in the vicinity of Meriden, Conn., in November, had also subsisted on Orthoptera to the extent of over 58 per cent of their food. In the stomachs of 6 of these, Orthoptera formed over 90 per cent of the contents.

Individual stomachs frequently contained surprisingly large numbers of crickets and grasshoppers. Inasmuch as information on this point is secured usually by counting the jaws of these insects, it often

[9] Marlatt, C. L., The Food Bill of Destructive Insects of the United States, Reclamation Record, vol. VIII, no. 9, p. 427, September, 1917.

happens that the undigested remains of previous meals are recorded, but from the rapidity of digestion observed in other passerine birds, it seems highly probable that all particles of a starling's meal will have either been digested or passed on to the intestines in the course of a few hours. With this fact in mind, the significance of the following data may be appreciated:

A juvenile bird secured in September had eaten 7 short-horned grasshoppers (Acrididæ), 1 field cricket (*Gryllus*), and no less than 47 small striped ground crickets (*Nemobius*); a second bird from the same flock had taken 5 grasshoppers, 2 field crickets, and 47 small striped ground crickets; and a third, 6 grasshoppers, 1 locustid (*Xiphidium*), 1 field cricket, and 42 small striped ground crickets. In 19 other stomachs the last-named insect numbered 20 or more Even the larger acridids were at times taken in quantity: A starling collected on September 2 had consumed 22, along with a locustid. Another had taken 16 acridids, 3 locustids, and 2 field crickets. A third ate 13 acridids, 3 locustids, 2 field crickets, and 1 small striped ground cricket.

Among the grasshoppers eaten by starlings were the red-legged locust (*Melanoplus femur-rubrum*), the green-striped locust (*Chortophaga viridifasciata*), and a number of the small grouse locusts (Tettiginæ). Besides the field cricket (*Gryllus pennsylvanicus*) and the small striped ground cricket (*Nemobius fasciatus*), a single specimen of the mole cricket (*Gryllotalpa borealis*) was taken. Additional related species were also eaten by nestling starlings, a discussion of whose relation to Orthoptera is presented on page 42.

### Lepidoptera (Mainly Caterpillars).

Lepidopterous remains in the food of the starling are composed almost entirely of the larvæ, or caterpillars, the greater part being consumed by nestlings (see p. 41). In the stomachs of adults these insects constituted 6.04 per cent of the yearly food. May and June are the months of greatest consumption, when such food forms 13.97 and 20.56 per cent, respectively, of the total. In September caterpillars formed less than 1 per cent (0.83) of the diet, while the remaining months of the year are represented with quantities varying from 1.04 per cent to 5.69 per cent of the food.

Of the 2,301 stomachs of adult starlings examined, 538 contained the remains of caterpillars; 20 contained pupæ; and 30, adult Lepidoptera. In June, the height of the caterpillar season, over half (115 of 205) of the adult birds used in this investigation had fed on Lepidoptera in one form or another, while in the preceding month 81 of 133 had taken such food.

Conspicuous among those birds which had fed extensively on caterpillars is a series of 31 adults collected in the middle of June,

near Flemington, N. J. Only one had failed to eat such food, which on the average formed 27.8 per cent of the bulk. In point of numbers, a starling collected at New Haven, Conn., takes the honors. In this bird's stomach were the remains of no less than 40 caterpillars, which formed 98 per cent of the food.

The terrestrial feeding habits of the starling limit the variety of caterpillars eaten, but this very restriction has permitted the bird to distinguish itself as a most effective enemy of that notorious pest, the cutworm. While caterpillar remains are not the most satisfactory items for identification in stomach contents and only occasionally are in condition for specific determination, the material in fully two-thirds of the starling stomachs could be referred with a fair degree of certainty to the family Noctuidæ.

Corroborative of what stomach examination has revealed is a bit of testimony secured from field observations on a farm at Adelphia, N. J., where starlings were observed doing exceptionally good work on the army worm. A rather heavy infestation of this insect had resulted in considerable damage, when a large flock of juvenile starlings started to feed regularly in the infested area; within a few days the worms had practically disappeared from those fields.

That other terrestrial caterpillars may find an enemy in the starling is recorded by an observer near Bloomfield, N. J., who, in the fall of 1915, witnessed starlings feeding on the larvæ of the cabbage butterfly.

In only a few instances were hairy or spiny caterpillars found in stomachs of adults. Among these were the American tent caterpillar (*Malacosoma americana*), an arctiid, and a "silver spot" (*Argynnis cybele*). One reason for not finding more spiny or hairy caterpillars may be explained by an incident observed at Norwalk, Conn., where a starling was seen to eat a tent caterpillar much after the fashion of the Baltimore oriole, by forcing out the soft parts and leaving the hairy skin hanging on the limb.

### Miscellaneous Insects.

Of other orders of insects from which starlings secure part of their sustenance, Hymenoptera, including bees, wasps, and ants, is best represented. This is of little importance, however, as the average monthly percentage is only 1.75, a great part of which is composed of ants. Most of this food is consumed during the summer, the monthly percentages from April to October inclusive being as follows: 1.11, 3.33, 3.41, 2.56, 2.14, 2.49, and 3.79. None of the late fall, winter, or early spring months were represented by as much as 1 per cent.

Connected with the capture of Hymenoptera is one of the oddest activities of the starling. While primarily terrestrial feeders, soon after the first of August young starlings were seen catching insects on

the wing, much after the fashion of true flycatchers. From a perch on a dead upper limb the birds would spy insects several yards away, fly out, and dexterously capture them. Later, after the first of October, starlings changed their tactics, adopting methods similar to those of swallows or martins in securing flying insects. The best illustration of these activities was furnished in northern New Jersey on a calm day above a warm, sunlit meadow. Here a dozen or more starlings were sailing about and capturing insects at a height of about a hundred feet from the ground. Under such conditions one not acquainted with the starling would certainly have mistaken the birds for martins, for, combined with a form which is quite similar, was this flight evolution, which imitated the martins perfectly.

Many ants in the winged stage are captured by starlings in their aerial evolutions, some are picked up on the ground, and others are secured from the branches of trees. On September 5 a number of juvenile starlings were noted diligentl searching for and picking up food from the upper branches of a spruce. To some extent their actions imitated those of chickadees or warblers, though they were not so sprightly. One of these birds was collected and its stomach found to be filled with ants.

Ants of the genus *Myrmica* are most frequently eaten by the starlings. *Lasius*, *Formica*, and *Aphænogaster* also are taken. Beneficial ichneumonoid Hymenoptera were found in over 75 of the 2,301 stomachs of adults, but in most cases only a single insect each. The infrequent occurrence of bees and wasps in the food also indicates that they, as well as the ichneumons, are picked up here and there, no special effort being made by the starling to secure them.

Hemiptera, true bugs, form only an unimportant part (less than 1 per cent) of the food of the starling. March is the month of greatest consumption, due mainly to the quantity of soldier bugs (Pentatomidæ) eaten, these offensively odored insects forming over 2.5 per cent of the food in this month. As both predacious and plant-feeding forms are found among these insects, the result of an indiscriminate feeding on soldier bugs must be construed as neutral in its effect. In fact, this same construction may be placed on all the Hemiptera eaten by starlings. Among the plant feeders were found the chinch bug (*Blissus leucopterus*), the squash bug (*Anasa tristis*), and the tarnished plant-bug (*Lygus pratensis*); and among the predacious forms, the assassin bug (*Sinea diadema* and *Melanolestes picipes*).

Diptera (flies and their larvæ) were present in only a limited number of stomachs and formed a little more than 0.5 per cent of the annual food. Much of this material is secured about garbage heaps and in the neighborhood of cattle, with which starlings are familiar associates. The birds have been seen picking flies from the legs of

cows and in a few instances actually alighting upon their backs with the apparent intent of catching flies. In pastures starlings secure maggots by visiting partially dried cow droppings, which they thoroughly riddle by puncturing with their bills. As this material dries it becomes pulverized and scattered over several square feet of surface. Under such treatment dipterous larvæ not actually eaten by the birds soon die for want of moisture.

### MILLIPEDS.

So far as known, no other bird in this country equals the starling in the destruction of millipeds. These creatures form 11.71 per cent of the adult bird's yearly diet. In April they amount to 54.69 per cent; in May, 42.19 per cent; and in June, 23.66 per cent; and, after a falling off in the later summer months, they again rise to 7.64 per cent in October. The fact that in April 119 adult birds of 132 examined, in May 133 of 140, and in June 146 of 215, had fed on millipeds, furnishes an idea of the persistence with which starlings search for such food in spring and early summer. Fifteen of the birds collected in April had taken nothing else, and 14 others had secured over nine-tenths of their food from millipeds.

At present the economic status of millipeds in this country is not fully understood. Were the theory accepted that was generally entertained a few years ago that millipeds feed entirely on decaying vegetable matter, the starling's destruction of them would have to be construed of neutral effect. In England, however, millipeds of the same and closely related genera are decidedly destructive in gardens, and recent investigations have shown that they have similar habits in this country. Damage to beans, strawberries, melons, cucumbers, radishes, and potatoes has been attributed to one species (*Julus cæruleocinctus*) which is a favorite food item of the starling. The full significance of the starling's destruction of millipeds will be known only when the habits of these animals are better understood. Whether their status be neutral or injurious, in feeding on them the starling secures a much needed supply of animal food and at the same time does not draw materially from the supply of other birds, few of which have shown a preference for millipeds.

### SPIDERS.

Spiders hold by no means the attraction for adult starlings that they do for the nestlings (see p. 43). Of the 2,301 stomachs examined, 480 contained spiders, which formed 1.48 per cent of the annual diet. In only one month did they constitute over 3 per cent of the food; in December, 17 of 44 birds had eaten spiders to the extent of 3.48 per cent of their food. Most of the arachnids eaten were wolf spiders (Lycosidæ), which are terrestrial in habits and generally

considered less distinctly beneficial than some of the other spiders which secure many of the flying insect pests in their silken nets.

### MOLLUSKS.

In contrast with the large numbers of injurious slugs secured by the starling in some parts of its native home, particularly in England, is the quantity and character of the molluscan food of the bird in this country. Mollusks of various kinds, but mainly land snails, formed less than 1 per cent (0.94) of its annual food. A large part of this was secured in October, when 20 of the 108 birds examined had fed on it. These 20 birds were collected along the Connecticut shore, the snails eaten being mainly of the genus *Melampus*. In no case was a land slug detected.

### MISCELLANEOUS ANIMAL FOOD.

The remains of earthworms, fragments of a crab, a few beach fleas (*Orchestia*), sowbugs (*Porcellio*), bones of a salamander (in one stomach), and bits of fat, suet, or cartilage, secured apparently from garbage dumps or at the winter feeding stations erected to attract birds, fill out the varied animal diet of the starling. All these items combined form only 1.32 per cent of the bird's yearly food, and most of them are secured during the winter and early spring months. That the bird's desire for animal food is in a measure satisfied as soon as the winter's snow disappears in March is revealed by the quantity of animal garbage consumed in that month, when it forms about 8 per cent of the diet. The main grievance against the starling for its consumption of the foregoing food items is entertained by bird lovers whose generous supplies of suet put out for native birds soon disappear when discovered by a flock of starlings.

### VEGETABLE FOOD OF ADULTS.

### CHERRIES.

One of the most frequent complaints against the starling is in connection with its fondness for cherries. From the economic standpoint, this is undoubtedly its most objectionable habit. The cherry is cultivated on a commercial scale in only a part of the starling's present range, but is grown as a home fruit, a tree or two about the dooryard, throughout most of its habitat. This condition renders the crop peculiarly susceptible to attack by robins and starlings, the two most abundant fruit-eating birds of the region.

In 1915, on a farm near Closter, N. J., trees that should have produced $50 to $60 worth of cherries yielded only $10 worth, a loss largely due to starlings. At Bristol, Conn., a flock of about 300 starlings entirely stripped a single tree of its 1916 crop in less than 15 minutes. At Rowayton, Conn., six cherry trees were entirely stripped

of their fruit by robins and starlings in 1916. These are but examples of the many instances which came to the notice of the writers while in the field of birds taking part or all of the fruit from isolated trees.

Of the 2,301 stomachs of adult starlings examined, 169 contained cultivated cherries, which formed 2.66 per cent of the yearly food of the species. Early cherries in June were eaten by 67 of the 215 birds examined, while late varieties in July furnished food for 91 of 375. In June, this fruit formed 17.01 per cent of the adult starling's food, and in July, 14.92 per cent.

Without attempting to mitigate the offense of the starling by calling attention to another notorious cherry thief, some idea of the extent of the starling's activities may be gained by comparing its food habits with those of the robin. From the examination of 1,236 stomachs of robins, it has been found that this species feeds on cultivated fruit to the extent of 8.63 per cent of its annual food, as against 4.41 for the starling. During the months of June and July, the robins obtained 24.58 per cent and 22.71 per cent, respectively, of their food from cultivated cherries, quantities half again as great as those consumed by starlings in the same months. Another matter of note is the number of complaints against the robin as compared with the number made against the starling for the same offense. This is in part due to the different methods of feeding employed by the two species. The robin is universally distributed and feeds in loose flocks, individuals of which may be found maintaining an almost uninterrupted procession to and from some favorite cherry tree for entire days. At no time will a great number of the birds be found in a tree, but the slow drain on the cherry crop is constant through all hours of daylight. The birds are frequently feeding young at this time and are carrying cherries to them. On the other hand, starlings, the young of which are the chief offenders, frequently gather in large flocks, and, swooping down on a single tree, completely strip it of fruit while other trees in the neighborhood may remain untouched. As a result, while practically every cherry grower complains of the robin, those who suffer from the more spectacular raids of the starling are much more bitter in their complaints. This condition led to an investigation at several points in Connecticut to determine the relative damage caused by several cherry-eating species, and trees were watched to determine as far as possible the number of birds eating the fruit. The summary of the data obtained is presented in Table I.

TABLE I.—*Comparison of depredations by various species of birds on cherry trees in Connecticut.*

| Date and length of time spent in each tree | Number of birds that came to eat cherries. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Robins. | Bobolinks. | Purple grackles. | Rose-breasted grosbeaks. | Baltimore orioles. | Red-winged blackbirds. | Cowbirds. | Red-winged blackbirds. | Blue jays. | Cuprous sparrows. | Total birds. |
| June 26, 2 hrs., 15 mins. | 12 | 17 | 7 | 1 | 2 | 1 | 2 | | | | | 42 |
| June 26, 1 hr., 15 mins. | 10 | 17 | | 6 | | | | 1 | 1 | | | 35 |
| June 27, 45 mins. | | 42 | 9 | | | | 1 | | | | | 52 |
| June 27, 3 hrs. | 8 | 24 | | 5 | 2 | 1 | | 1 | | | | 31 |
| June 27, 1 hr. | | 15 | 2 | | | | | | | | | 17 |
| June 29, 3 hrs., 30 mins. | 30 | 4 | | 4 | | | | | | | | 38 |
| July 4, 30 mins. | 1 | 30 | | 1 | | | | | | | | 32 |
| July 5, 1 hr. | 20 | 5 | | | | | | | | | | 25 |
| July 10, 1 hr. | 3 | 24 | 4 | 3 | 2 | 3 | | | | 4 | 5 | 46 |
| Totals | 113 | 197 | 22 | 22 | 6 | 5 | 3 | 2 | 1 | 4 | 5 | 370 |
| Percentage | 30.5 | 53.2 | 5.94 | 5.94 | 1.62 | 1.35 | 0.81 | 0.54 | 0.27 | 1.08 | 1.35 | ..... |

On examination of this table it is found that about half the birds feeding on cherries were robins, less than a third were starlings, and the others were of various species, none numerous enough to be of any consequence. This interesting bit of evidence is confirmed by stomach analyses of robins and starlings. The stomachs of 11 robins, collected while feeding in cherry trees, contained 10.27 per cent animal matter and 89.73 vegetable matter, of which 85.78 per cent was cultivated cherries. Forty-nine starlings, obtained under the same circumstances, had fed on animal matter to the extent of 58.12 per cent of their food; and vegetable matter, 41.88 per cent; cultivated cherries formed 36.72 per cent of the total.

It was the experience of the writers that shooting a few starlings from cherry trees soon discouraged the survivors so effectually that they seldom returned. The robins, on the other hand, were exceedingly bold and paid no attention to any frightening devices placed in the trees or to shooting. Frequently a starling or a robin was shot from a tree without alarming other robins feeding.

From the above data it will be seen that the starling eats fewer cherries, both individually and as a species, than the robin, although his attacks are much more conspicuous. According to most observers, the robin, as well as the starling, increased considerably in numbers in the decade following 1910 throughout the area covered by this investigation, and both species are undoubtedly responsible for the increasing difficulties of cherry culture. Both species have habits to recommend them on economic grounds, with the starling in the more favorable position on account of its smaller consumption of fruit and much larger consumption of noxious insects.[1]

[1] For a detailed report of the stomach food see Forbes, the Robins and Bluebirds of the United States, by F. E. L. Beal, Bull. 171, U. S. Dept. of Agr., pp. 7–10, 1911.

### BERRIES.

Some complaints of damage to strawberries have been made, but the investigation failed to reveal extensive depredations by the starling. A few farmers in New Jersey stated that the birds occasionally ate berries, and one farmer in Connecticut shot 9 birds out of a flock that started in on his berry patch. At the discharge of the gun the starlings flew away and did not return. Little complaint was made of damage to blackberries or raspberries, and as in most places wild varieties are more abundant than cultivated ones there is little danger of the starling doing much damage to such fruits.

### APPLES.

Field work conducted in September and October was devoted largely to investigating complaints about starlings damaging late fruits, particularly apples. Extensive inquiries were made among the farmers in those sections of New Jersey and Connecticut where the starling was common, and no opportunity of collecting in orchards was overlooked. Considering the time and attention given to this phase of the subject, it must be stated at the outset that positive incriminating evidence against the starling secured from personal observation and stomach analysis is small.

Of the 2,301 stomachs of adult starlings examined, 45 contained the pulp or skin of apples. Only 22 of the 45, however, were among those collected in September and October, the remainder having been taken in winter and early spring, when the fruit eaten was manifestly waste, left on the trees or fallen to the ground. In bulk, cultivated fruit other than cherries, of which a large part was apples, formed 1.75 per cent of the total annual food. In September it amounted to 2.19 per cent, and in October, 0.38 per cent. A large part of the stomachs in which apples occurred were secured in small orchards in the vicinity of Adelphia, Monmouth County, N. J., whence several complaints had come.

On September 22, 1916, a flock of 200 or more juvenile starlings were seen feeding on apples in a small orchard of middle-aged trees near Adelphia. Only a few appeared to be eating the fruit, the remainder being engaged in singing or preening their feathers. Afterwards the trees were inspected. The apples in the central top of the trees were the ones sampled, and in many instances it was noted that the birds had gone back to feed on fruit pecked open on previous occasions. An opening an inch or two in diameter was pecked in the skin and then a large portion of the pulp was eaten out through this break (see Pl. IV, fig. 2).

On the following day a flock of birds was observed at work in a tree of russet apples on a neighboring farm. Subsequent inspection of

the fruit in the tree top showed that probably not over 5 per cent of the apples had been pecked.

At Glen Cove, N. Y., a flock of about 100 starlings was noted attacking the fruit in one tree of an orchard where damage had been reported in previous years. On this occasion about one apple in every five was damaged. The owner of this orchard, who was a keen observer of birds, asserted that starlings had ruined 10 per cent of his crop in 1915. Of 30 barrels picked, 3 had to be discarded.

Isolated apple trees, especially those standing in the middle of hay fields where flocks of juvenile birds are accustomed to feed on insects, are likely to have their fruit damaged. Such a tree at East Norwalk, Conn., had nearly every apple pecked, and a similar one was found near Farmington, N. J., but in neither case was the crop of any value, and it was never harvested.

Late-maturing varieties are more likely to be attacked by starlings than those ripening at the height of the apple season, owing possibly to the fact that the supply of wild fruit, as wild black cherry (*Prunus serotina*) and sour gum (*Nyssa sylvatica*), has been materially depleted by that time. The starling's taste for apples, combined with its flocking habit, presents a condition which should be watched because of the bird's capacity for damage. At present, however, the aggregate damage done is not great. On no farm given largely to fruit-raising, where the trees were thrifty and well kept, was injury to apples observed or reported. The number of extensive fruit raisers in areas of starling abundance who had no complaint to make is legion. At present the bulk of the damage is confined to old orchards and isolated trees. In many cases the damaged fruit is on trees sadly neglected and of inferior quality.

### PEARS AND PEACHES.

In only three stomachs was the pulp of pears found (twice in September and once in January) and field work also yielded little positive evidence that the starling damages this fruit. One report from Ambler, Pa., asserted that in 1915 starlings had ruined a whole tree of pears; additional reports of damage came from Bloomfield, N. J., but in none of these was the loss great. Injury to peaches is also slight—one of the more specific reports came from a farmer of Warren, R. I., who stated that in 1914 he had lost about 2 per cent of his crop on account of starlings.

### GRAPES.

To a limited extent starlings have exhibited in this country the same habits that have made them unpopular during late summer in the vineyards of France. Testimony on this point comes entirely

from outside observers. No grapes were found in the stomachs examined and no damage of this kind was observed by representatives of the Biological Survey. A farmer in the Brookdale section north of Bloomfield, N. J., reported that starlings had severely damaged grapes on a small arbor on his farm, and similar complaints came from a number of farmers in the neighboring sections about Richfield, N. J. No damage was reported in the extensive vineyards about Vineland, in southern New Jersey, but as the starling was not yet abundant there this can not be looked upon as an indication of its innocence. As in the case of apples, the injury to grapes is at present trivial in the aggregate and is practically nil in extensive grape-raising sections, but from the starling's reputation in some parts of Europe it will bear watching in these surroundings.

### CORN.

Probably the losses to crops most keenly felt by the farmers living in the intensively cultivated area in northeastern New Jersey, about the cities of Hackensack, Bloomfield, Elizabeth, and Newark, are those inflicted by grain-eating birds on sweet corn. During July and August mixed flocks, sometimes numbering into the thousands, of grackles, red-winged blackbirds, cowbirds, and, in recent years, starlings, roam through the country, securing the bulk of their sustenance from cornfields. Sweet corn, just ready for market, is torn open, some of the juicy kernels eaten, and the ear either rendered unsalable or its market value considerably reduced. In the aggregate such losses are very great and in the eyes of the farmers of northeastern New Jersey, the starling is to blame for a large share of the damage. However, as in the case of men, who are often judged by their company, the starling has been accused of deeds perpetrated largely by the species with which it associates. Not only were these birds generally charged with eating as much corn as the grackles and red-wings, an assumption which has been disproved, but many farmers were uncertain of their identification, with the result that flocks of juvenile red-wings were often called starlings and their depredations charged against the latter.

Of the total of 2,301 adult starling stomachs examined, 52 contained corn, and this formed less than 1 per cent (0.77) of their yearly food. Of the 1,059 starlings collected during the ripening and harvesting season of July, August, September, and October, only 14 had fed on corn, which constituted only 0.2 per cent of their food during this period. In the planting and sprouting season of April and May, 6 of 249 adult starlings had fed on corn, which formed 0.52 per cent of the food. By far the largest part of the corn eaten by starlings is waste grain secured in winter and early spring. In Jan-

uary corn forms 1.54 per cent of the diet, in February 2.03 per cent, and in March 3.49 per cent, the largest proportion recorded for any month.

While the result of the examination of so large and thoroughly representative a series of stomachs refutes all the extreme accusations against the starling as a corn eater, a discussion of field observations made in this connection will emphasize this point and show where the blame lies. A number of complaints had come from the vicinity of West Englewood, N. J. This section was visited in the middle of August, when a survey of some of the most seriously damaged fields was made. Much of the sweet corn had been harvested, but there were still some fields of the late varieties in which birds were at work, and in patches of early corn saved for seed a record of their activities earlier in the season was found. A farmer of West Englewood, who is familiar with the starling, reported that starlings joined with red-wings in damaging his crop. A census of part of a seed patch on his farm showed that of 863 ears of sweet corn examined, 231 had been injured by birds, a percentage of over 26. On another farm at Teaneck, N. J., fully 33 per cent of the seed corn had been damaged. Examination of a field at River Edge, N. J., revealed 100 damaged ears out of 297 inspected. Several other seed patches in this general vicinity were even more seriously damaged, in one case on several hundred stalks scarcely a single ear being left unmutilated.

An insight of what species were doing such work, and were probably also to blame for most of the injury to seed patches earlier, was secured on a farm near West Englewood, N. J., on August 23. Here a mixed flock of red-wings and grackles were feeding on a field of sweet corn in which pickers were at work. The field was large and the birds would feed in parts distant from the pickers. The owner asserted that already he had 2,500 ears damaged, and that while many of these were still salable they brought reduced prices, only 50 to 75 cents per 100 being paid instead of $2, the market value of perfect ears at that time. A careful watch for several days in this and surrounding fields failed to disclose a single starling feeding there, while the red-wings and grackles spent little time elsewhere. Juvenile red-wings were generally considered starlings by the farmers of this locality.

On a few occasions the investigators observed starlings actually tearing down the husks of corn and feeding on the kernels, but in no case were starlings in large-sized flocks seen inflicting serious damage. Positive incriminating testimony has come, however, from other observers. A reliable observer of Glastonbury, Conn., has seen flocks, composed entirely of starlings, doing damage to the corn crop in two fields to the extent of 25 per cent and 10 per cent, respec-

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FIG. 1.—SWEET CORN DAMAGED BY MIXED FLOCKS OF STARLINGS AND RED-WINGED BLACKBIRDS.

Only a small portion of the corn in this patch, saved for seed, was harvested, owing to the depredations of birds. Red-winged blackbirds were chiefly to blame.

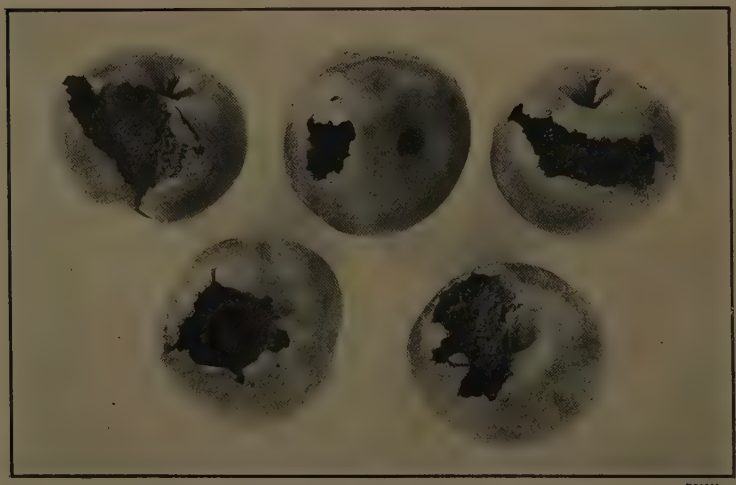

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FIG. 2.—RUSSET APPLES DAMAGED BY STARLINGS.

These apples were from the tops of trees in an old orchard near Adelphia, N. J. Some of the damaged fruit showed evidence that the birds returned to an apple opened on a previous visit.

tively. A resident of Rochelle Park, N. J., who is well acquainted with the starling, asserted that for several years past these birds had taken toll from his fields. Others also have seen the starlings, while part of a mixed flock, actually feeding on the ears of corn.

Damage to field corn was reported less frequently than to sweet corn, and the reports were subject to the same errors of identification of birds. On one farm west of West Caldwell, N. J., the starling was bitterly criticized for its work on a 2 to 3 acre patch. Some time was spent observing the bird visitants to this field, and it was found that English sparrows were busily engaged in tearing down the husks for an inch or two, as far as their strength allowed, and eating the terminal kernels.

In the vicinity of Freehold, N. J., where a large starling-grackle roost was located, flocks of starlings were common about the middle of September in the near-by cornfields. Many of the birds would perch on the top of the cornstalks and sing, fully as many would be on the ground apparently in search of insects, and a few could be noted pecking the ends of the ears. One field of several acres appeared to be a favorite resort, and earlier in the year, when the corn was in the milk, damage had been done there. The proprietor asserted that early in August, when most of the corn was damaged, starlings in a large flock visited his field twice daily, morning and evening. A count in part of the field showed that of the 522 ears examined 136, or more than 26 per cent, had been visited by birds. Over half the opened ears, however, showed the unmistakable track of the corn worm. It is highly probable that the birds often devoured the insects they exposed in tearing down the husk. Another field, northwest of Freehold, which was visited by large flocks of starlings in early morning and late afternoon, was carefully inspected, and very little bird work was found, but a heavy infestation of corn worms had severely damaged the crop.

A comparison of the food habits of the starlings and grackles occupying the Freehold roost in September was obtained from the examination of material collected there. Six of the 116 starlings had fed on corn, and in the stomach of one, this grain formed 94 per cent of the contents, in another 60 per cent, in a third 12 per cent, and in the remaining three only 1 per cent each, making an average percentage of about 1.5 for the lot. Twenty of the 27 grackles shot at the same roost had fed on corn, and in 11 this constituted the entire stomach contents. The corn consumed by the 27 grackles formed over 76 per cent of their food. With this was over 11 per cent of other grain, principally oats.

To a limited extent starlings were accused of pulling sprouting corn, both sweet and field varieties. At Mendham, N. J., it was

reported that starlings had pulled nearly an acre of corn in one field, and at Spring House, Pa., it was asserted that starlings had pulled corn so badly on a 10-acre field that it had to be replanted.

While laboratory examination shows that the starling is not an extensive feeder on ripening corn, field observation indicated that where local conditions are favorable, as in the vicinity of roosts, the birds may do damage. The aggregate loss to the corn crop which can be definitely attributed to the starling is not great. Many of the complaints against the starling have been based on a misidentification of the species—red-winged blackbirds and grackles being more frequently responsible. The aggregate loss to sprouting corn is trivial. The fact that starlings are easily frightened by gunfire and will shun an area after a day or two of shooting suggests effective preventive measures, which have not proved successful in the case of the other two species mentioned.

### SMALL GRAIN.

The farmer has little need to fear the starling as a menace to small grains. Twenty of the 2,301 adult birds examined had fed on small grain, and of these 13 had eaten wheat, 6 oats, and 1 millet. In bulk this formed 0.39 per cent of the food, and fully half of this was eaten at a time of year when it manifestly must have been waste. The few complaints on this score were either so trivial in nature or so widely separated that the aggregate injury is not important. The complaints involved the picking up of newly sown oats, the "pulling" of sprouting oats, and feeding on ripened wheat and millet. At Sound Beach, Long Island, a flock of about 500 starlings was noted feeding in a millet patch, the owner of which claimed that the birds had eaten all the seed from a similar patch in the previous year and that it appeared as if they would repeat the performance.

### GARDEN TRUCK.

From the impossibility of satisfactorily identifying such food items as chewed-up bits of lettuce and spinach leaves, tender pods of peas, pulp of tomatoes, etc., it is apparent that stomach examination does not satisfactorily determine the relation of the starling to garden truck. In no case were such items positively identified in stomachs, though reliable field observers have witnessed attacks on these and other products of the garden at odd times. The depredations are confined mainly to small city gardens, where the succulent green foods are readily accessible to an unusually large number of starlings. In intensively cultivated truck-crop areas, as in the Brookdale section, north of Bloomfield, N. J., similar conditions sometimes prevail.

An observer of Stratford, Conn., has witnessed starlings pecking holes in his tomatoes, and an extensive grower of tomatoes at Stratford asserted that of the first three crates of tomatoes picked in 1917 one had to be discarded, owing to the work of starlings. A farmer of Brookdale, N. J., has suffered losses to late tomatoes, and near-by growers complained that starlings scratched out seeds of radish, parsley, and spinach when these were sown under manure in winter and very early spring. Similar complaints were heard in Richfield, south of Paterson, N. J. At Demarest, N. J., a muskmelon patch was inspected after starlings had been at work pulling the young sprouts. Of about 15 hills of 3 or 4 plants each only 7 plants remained. On this same farm starlings took all of two plantings of onion sets in a small garden near the house. On a farm west of Oradell, N. J., sprouting lima beans shared the same fate, and in a small garden in Hackensack, N. J., 150 young lettuce plants were "pulled." A resident of Bay Shore, N. Y., had many of his green peas taken by starlings.

These instances are typical of the damage starlings may do to gardens. In the main their work is confined to small plots, and the losses are most keenly felt by the city dweller who has painstakingly tilled and planted a few square yards of soil. In the extensive truck-crop sections the aggregate damage of this kind is not great.

### WILD FRUIT.

The starling is essentially an insect-eating and fruit-eating bird, and wild fruits form the largest single item in its yearly food (23.86 per cent). Both the quantity and variety naturally change with the season. In May, when millipeds, beetles, and other insects are abundant, wild fruit disappears entirely from the diet. The first half of June sees little change in the food habits, but as cherries begin to ripen the birds begin to flavor their diet with fruit, wild as well as cultivated; and mulberries (*Morus rubra*) and June berries (*Amelanchier*) form practically all of the 1.1 per cent of wild fruit taken in this month. In July, with the ripening of red and white mulberries, the starlings enter on a veritable orgy of fruit eating, which continues until well into October, as one species of fruit after another ripens. In July, 35.82 per cent of the food consists of wild fruit, practically all of which is mulberries and blackberries. A rather open country, with occasional groups or single trees of mulberry or wild cherry, furnishes an ideal feeding ground for the flocks of young starlings which wander over the country during the summer and fall months.

Early in August the chokecherry (*Prunus virginiana*), and later in the month the black cherry (*Prunus serotina*) and the elderberry (*Sambucus canadensis*), supply the bulk of the 40.88 per cent which

represents the fruit consumption for this month. Other fruits taken in small quantities give variety even in the fruit portion of the diet.

The 39.51 per cent of fruit consumed in September consists principally of the black cherry, which holds over from the preceding month, sour-gum berries (*Nyssa sylvatica*), Virginia creeper (*Psedera quinquefolia*), elderberry (*Sambucus*) and small quantities of many other fruits which ripen at this season.

By the first week in October many of the juicy berries are gone, although Virginia creeper and sour gum still furnish a considerable supply. These, however, soon disappear, and other sources of food are found in the immense number of grasshoppers present at this season and in bayberries (*Myrica carolinensis*). These dry, hard berries furnish the bulk of the 23.76 per cent of wild fruit found in the stomachs collected in this month, and supply a staple food throughout the winter.

Wild fruit enters into the winter food in the following percentages: November, 41.80; December, 36.44; January, 19.98; February, 32.90. In all four months practically the only fruits taken are the waxy bayberries and the seeds of the various species of *Rhus*, all of which are dry and hard, thinly covered with fruit pulp and skin. The starling apparently feeds on them only when unable to secure any other food. Whenever snow is off the ground the birds commence to search for insects and return to the sumac and bayberries only when compelled to do so by a fresh snowfall. In March, although there are few insects available, the feeding on wild fruit shows a decrease of over one-half, only 13.69 per cent of the month's food coming from this source. Garbage replaces it to a large extent, and it is apparent that the melting of the snow enables the birds to feed more on the ground and depend less on the hard berries on which they had so largely subsisted during the winter.

April, with its increasing abundance of early insects and millipeds, shows a practical abandonment of fruit eating by the species. Only 0.34 per cent of the food for this month is fruit, and this consists of a few seeds of *Rhus* and *Myrica* which escaped the winter's gleaning and have been picked up one or two at a time by different birds.

During the five months from October to February the starling takes the seeds of poison ivy (*Rhus toxicodendron*) in quantities varying from 1.42 per cent in January to 7.77 per cent in December, and, while this item forms only 1.71 per cent of the annual food, it is of some economic importance. The seeds are eaten, as are all other berries of a similar nature, simply for the thin outer covering of pulp and skin, and the hard parts pass through the digestive tract or are regurgitated, their germinating qualities uninjured. The starling thus becomes an agent in their dissemination, but as the birds so often roost over city streets or in buildings, part of these seeds are

deposited in places where they can not grow. In the actual spread of this noxious weed, the starling is probably less responsible than many of our native birds, which scatter most of their regurgitated seeds where they have at least a fair chance for growth.

### MISCELLANEOUS VEGETABLE FOOD.

Of the total annual food of the starling 13.57 per cent may be classed as miscellaneous vegetable matter. This consists almost entirely of refuse eaten during the winter months, as coffee grounds, orange seeds, beans, parings of various fruits and vegetables, and similar material commonly found on garbage piles. Mast and various grass and weed seeds are also present in insignificantly small quantities. Ragweed (*Ambrosia artemisiifolia*) and foxtail grass (*Chætochloa glauca*) were most commonly found, and as the starling habitually feeds in fields and pastures containing an abundance of these two weeds, it is not surprising that a few seeds are occasionally taken.

The garbage eaten has no economic significance, even so indirectly as the cutting down of the available food of native birds, as they seldom resort to such food.

### FOOD OF NESTLINGS.

From an economic standpoint, the food habits of nestling passerine birds are, as a rule, more commendable than those of the adults, and when one considers that during the nestling period the young birds of many species outnumber the parents two to one, the importance of knowing what they are capable of doing is manifest. Then, too, it must be remembered that the food required for the young growing bird is vastly more than that needed for its parent. During the first few days of the nestling's life, especially, it consumes enormous quantities of food, estimated in the case of some species to be on each day a mass equal to its own weight. This demand for food, much of which consists of injurious insects, is greatest during May, June, and July, a time when growing crops are benefited most by a suppression of their insect enemies.

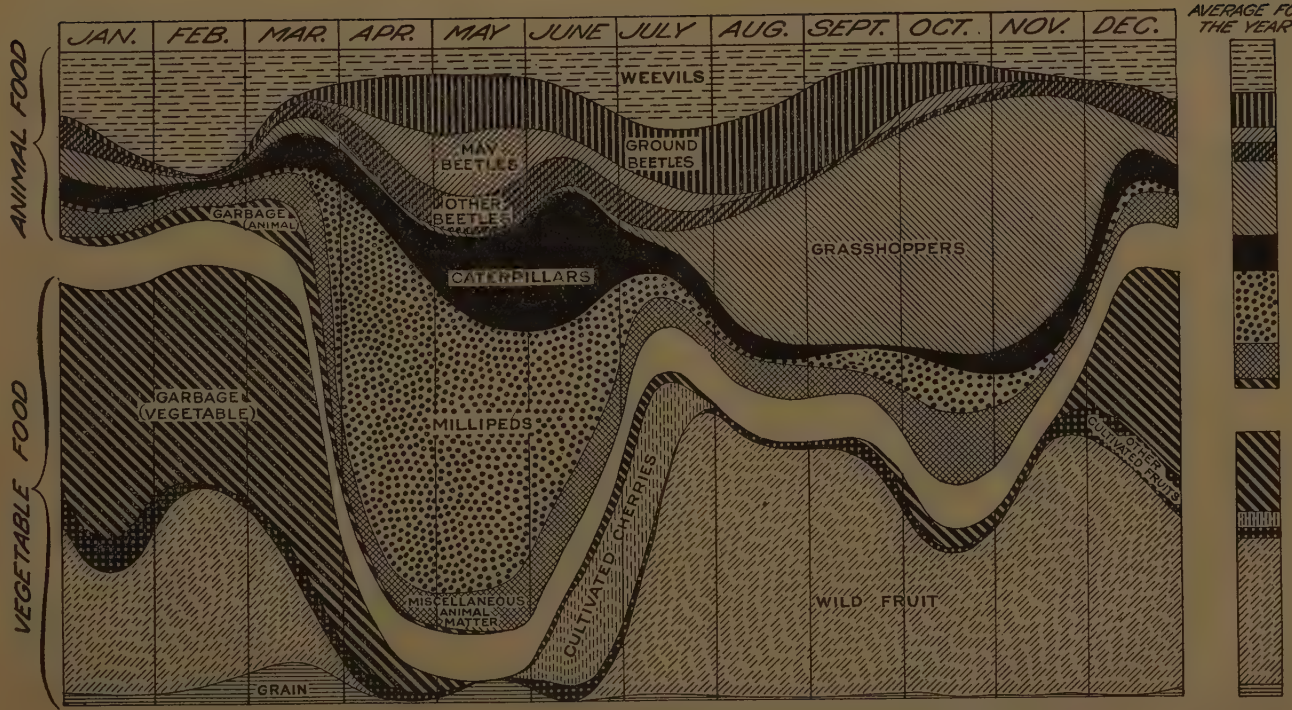


FIG. 2.—Chart of food of 2,157 adult starlings, showing the varying quantities of the principal items from month to month, and the relative monthly average of each item. In Table II, page 39, the same information is presented in percentages.

TABLE II.—*Monthly percentages of the various items in the food of adult starlings (see fig. 2).*

| Kind of food. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Monthly averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weevils | 14.10 | 20.16 | 7.97 | 4.35 | 4.31 | 7.39 | 13.36 | 10.91 | 3.93 | 3.13 | 5.33 | 7.00 | 8.50 |
| Ground beetles | 1.23 | 0.42 | 1.07 | 7.31 | 8.76 | 7.96 | 9.11 | 13.02 | 12.93 | 4.56 | 1.16 | 1.12 | 5.71 |
| May beetles | 0.14 | ..... | 0.27 | 4.52 | 11.04 | 3.28 | 4.08 | 0.45 | 0.38 | 2.60 | 0.10 | 0.05 | 2.24 |
| Other beetles | 2.27 | 0.49 | 2.39 | 6.55 | 6.23 | 4.56 | 3.70 | 1.76 | 0.75 | 1.15 | 2.27 | 5.54 | 3.14 |
| Grasshoppers | 4.42 | 0.55 | 2.61 | 1.59 | 0.84 | 1.24 | 2.77 | 22.30 | 30.75 | 38.95 | 38.26 | 4.76 | 12.41 |
| Caterpillars | 3.88 | 1.04 | 5.24 | 5.56 | 13.97 | 20.56 | 4.57 | 3.69 | 0.83 | 2.16 | 5.69 | 5.26 | 6.04 |
| Millipeds | 0.44 | 0.04 | 0.66 | 54.69 | 42.19 | 23.66 | 3.68 | 0.20 | 4.11 | 7.64 | 1.24 | 2.02 | 11.71 |
| Miscellaneous animal matter[1] | 3.91 | 3.07 | 6.23 | 5.26 | 6.98 | 10.80 | 5.71 | 5.56 | 3.56 | 11.83 | 3.01 | 5.05 | 5.93 |
| Garbage (animal) | 1.69 | 2.40 | 8.15 | 1.39 | 0.63 | 0.32 | 0.35 | 0.32 | ..... | 0.23 | ..... | 0.36 | 1.32 |
| Garbage (vegetable) | 40.56 | 35.97 | 41.25 | 6.76 | 4.58 | 1.04 | 1.49 | 0.34 | 0.54 | 3.61 | ..... | 26.62 | 13.57 |
| Cultivated cherries | ..... | ..... | ..... | ..... | ..... | 17.01 | 14.92 | ..... | ..... | ..... | ..... | ..... | 2.66 |
| Other cultivated fruits | 5.84 | 0.66 | 2.87 | 0.76 | ..... | 1.06 | ..... | 0.50 | 2.19 | 0.38 | 0.96 | 5.78 | 1.75 |
| Wild fruits | 19.98 | 32.90 | 13.69 | 0.34 | ..... | 1.12 | 35.82 | 40.88 | 39.57 | 23.76 | 41.80 | 36.44 | 23.86 |
| Grain | 1.54 | 2.30 | 7.60 | 0.92 | 0.47 | ..... | 0.44 | 0.07 | 0.46 | ..... | 0.18 | ..... | 1.16 |

[1] Under this heading are included Hymenoptera, Hemiptera, Diptera, and other miscellaneous insects, spiders, and mollusks.

## OBSERVATIONS FROM BLIND.

Few birds are more voracious than young starlings, and when there are from 4 to 6 to feed, it requires the most strenuous efforts of their naturally active parents to supply their constant needs. An insight into the feeding operations was obtained near Closter, N. J., by means of a blind, from which a nestful of 5 young starlings could be watched at close range. This blind was so placed that the opening made for observation was within 2 feet of the nest cavity. This was located about 6 feet from the ground in the hollow limb of an apple tree. In watching these birds, attempt was made to identify the food brought in and to determine the frequency of feeding.

Efforts at identification met with little success, as in no case could an item be specifically identified, even though much of the food was carried in plain view at the tip of the bill of the parent bird and often within 18 inches of the eyes of the observer. The alertness of the bird prevented more than a momentary glance at the food it carried. Such identifications as "cutworms," "earthworms," "grasshoppers," and "ground beetles" were the best that could be made under the circumstances; and then, since fully a third of the food of the starling is carried where it is partially or wholly concealed at the base of the bill or in the throat, this phase of the observations afforded few facts of value—very little compared with the detailed data secured from stomach examination. It was noted, however, that rainfall had a distinct effect on the character of food brought to the young. During showery weather or on days succeeding rainy nights large quantities of earthworms and cutworms were secured. The main source of this supply was a near-by garden. A low meadow was a favorite

feeding ground during drier weather, and it was here that the birds secured most of their beetle food.

Observations as to the frequency of feeding gave more satisfactory results. Although the starling is extremely cautious in its feeding operations, this characteristic was less pronounced in the pair used in this observation, owing to the fact that the nest was situated within a few feet of the crossing of two well-traveled roads, and frequently the parent birds would sit calmly in the tree while several vehicles and pedestrians would pass within 20 feet. Little concern was shown over the presence of the blind, but of the two birds the male was by far the more cautious and at times would be frightened away from the nest by some cause or other, thus delaying a feeding. It often happened that the female would make several feeding trips while the male was thus alarmed, and on one or two such occasions the female attacked her mate, after which he would obediently visit the nest and feed the young.

In nine days a total of 390 feedings were recorded, in 14 periods varying in length from 30 minutes to 4 hours and 41 minutes. One hundred and four of the feedings were by the male and 286 by the female. An average of one feeding every 6.1 minutes was maintained for the whole period of observation, 31 hours and 10 minutes. The highest rate was recorded on the morning of May 18, which was probably the seventh day of the nestlings' life. A feeding every 3.2 minutes was maintained for 4 hours and 41 minutes. The lowest rate, once every 11.7 minutes, occurred on May 25, the day before the young left the nest.

On the basis of one feeding every 6.1 minutes, and assuming that the young are fed 12 hours a day, which is conservative, there would be 118 feedings a day. As this brood left the nest on the sixteenth day, which is probably several days short of the normal nestling period of the starling, for the birds were disturbed considerably during the latter days of their nestling life, a total of 1,888 feedings would have been given to this brood of five, or 377.6 for each nestling. When it is borne in mind that the parent birds would often bring in three or four cutworms, earthworms, or grasshoppers, or an equal bulk of miscellaneous insect food, at a single trip, one may gain an idea of the quantity of food required to develop a brood of young starlings.

### STOMACH EXAMINATION.

For detailed study of food items an excellent series of 325 stomachs of nestlings, collected in Connecticut, New York, and New Jersey during May, June, and July, was available. Sixteen of these, however, contained so little food that they could not be used in estimating percentages, leaving 309 for such purposes. Nestlings in all stages

of growth, from the blind, callow young of a day or two to the husky, energetic fledgling ready to leave the nest, are about equally represented, with the result that the percentages of the various food items may be considered to be fair averages for the entire nestling period. It is well known that as nestlings grow older there is a gradual change in food preferences. A discussion of the change of food habits in the growing nestlings, based on this material, grouped according to the age of the birds, will be found in Table III, on page 44.

### ANIMAL FOOD.

Compared with the 338 stomachs of adult starlings collected in May and June, it is found that the percentage of animal matter eaten by nestlings is somewhat greater, 95.06 per cent in place of 82.36. By far the largest animal item consisted of caterpillars, which, along with a few moths and a cocoon or two, formed 38.21 per cent of the food of young starlings and were present in 274 of the 325 stomachs examined.

To very young birds caterpillars are especially attractive. Only 3 of the 79 nestlings estimated to be less than 6 days old had failed to eat these larvæ. In the stomachs of 10 of these, caterpillars formed over three-fourths of the food, while the average for the lot was nearly half. In the case of two nestlings, apparently more than 10 days old, caterpillars formed the entire stomach content.

A large part of the caterpillars eaten by the starling are cutworms, a fact which may be attributed to the bird's habit of searching for insect food on the ground. Cutworms are chiefly nocturnal in their habits, but their high percentage in the food of young starlings indicates either that they are secured by the parents from beneath the surface or, which is likely, that a part are picked up in the early morning hours before the insects have secreted themselves for the day.

Beetles of various kinds constitute the next largest item (29.98 per cent) in the food of nestlings, of which nearly half (14.58 per cent) are members of the family Scarabæidæ, in which is found that notorious pest, the white grub, better known to the city dweller in its adult form, the May beetle (*Phyllophaga*). During late May and early June adult May beetles are favorite items of food with young starlings. One brood of 4 nearly fledged young had been fed entirely on these insects, at least 32 individuals being eaten, and another brood of 4 had eaten 27, which constituted 82 per cent of their food. As would be expected, the larvæ of these beetles are seldom eaten unless the parent birds are securing food on newly plowed fields. A few other phytophagous scarabæids of the genera *Euphoria*, *Ligyrus*, *Cotalpa*, *Anomala*, *Diplotaxis*, and *Serica* also were eaten, but in no case were the insects of economic importance or the quantity taken worthy of note. Nestling starlings eat by no means as

many coprophagous scarabæids as do their parents, who, in late summer and in fall, capture numbers of the common small genera on the wing. Of these, *Aphodius* appears to be the favorite for the nestlings.

Ground beetles (Carabidæ) formed a little more than 8 per cent of the young starlings' food, a proportion about equal to that taken by the adults in May and June. They were found in two-thirds of the stomachs examined, but in only one case was the quantity taken more than half the stomach contents. Conspicuous among the distinctly beneficial carabids eaten is the fiery caterpillar hunter (*Calosoma calidum*). This insect was identified in 17 stomachs. The large *Harpalus caliginosus* was present in 54 stomachs, *Chlænius tomentosus* in 46, and members of the genus *Anisodactylus* in 76. The presence of a considerable number of the last-named genus, together with specimens of *Amara*, show that not all the ground beetles eaten should be charged against the starling, as some of them are distinctly vegetarian.

The young starlings' consumption of weevils is nearly three times as great as that of the adults during the same period, and while in bulk the portion taken is small (3.26 per cent), it contains one item of considerable interest, the clover leaf weevil (*Hypera punctata*). (See Pl. III, fig. 1.) This insect constituted by far the largest portion of the weevil food. It was present in 53 stomachs, and the larvæ occurred in 34. One brood of 3 newly hatched young had been fed a total of 59 of these larvæ, which, together with 3 adult weevils of other genera, formed nearly 70 per cent of their food. The best record for the destruction of adult weevils was made by a brood of 4 half-grown nestlings that had consumed 30 individuals of two other clover pests (*Sitona hispidula* and *Phytonomus nigrirostris*) along with a number of billbugs (*Sphenophorus* sp.).

The remaining beetle food, comprising 4.11 per cent, was divided among a number of families. Leaf beetles (Chrysomelidæ) and rove beetles (Staphylinidæ) were best represented, but in no case was the quantity eaten of importance.

As the nestling period is too early in the season to permit a heavy consumption of grasshoppers, a large part of the orthopterous remains found (11.31 per cent) was composed of crickets. These were present in 134 stomachs, frequently associated with a grasshopper or two. One brood of 4 young starlings about ready to leave the nest had eaten 19 crickets and 4 grasshoppers, which totaled over 81 per cent of the food; another brood, just hatched, had been fed 13 crickets and 7 grasshoppers, which formed over two-thirds of their diet; and in the case of two other broods of 4 and 5, respectively, the orthopterous food constituted over two-thirds of the stomach contents. Most of the crickets eaten by nestlings are the common field cricket

(*Gryllus pennsylvanicus*), while many of the grasshoppers belong to the genus *Melanoplus*.

There is nothing of particular interest in the remaining insect food of young starlings. None of the other orders were represented by as much as 1 per cent. Among the Hymenoptera eaten, ants were prominent, and of the Hemiptera, soldier bugs (Pentatomidæ) formed the greater part.

Of animal items other than insects, spiders are most conspicuous. They were present in 182 of the 325 nestling stomachs examined and formed 8.56 per cent of the food, compared with 1.28 per cent of that of adults for the same period. Spiders are especially acceptable to nestlings of a day or two, as their thin-walled stomachs are unable to assimilate hard food. These creatures were found in the stomachs of 71 of 79 starlings less than 6 days old, and brood after brood was found in which every individual had been given one or more spiders. In some instances upward of a hundred were found when an egg sac filled with young spiders had been swallowed. A large part of the spiders eaten belong to the family Lycosidæ, the wolf spiders, which are terrestrial in habit and are generally considered less beneficial than those species which construct webs for the capture of flying insect pests.

The greatest difference between the food habits of old and young starlings is in the quantity of millipeds eaten. These form nearly a third (32.95 per cent) of the sustenance of the adult birds during May and June, but less than a twentieth (4.56 per cent) of the food of the young. In the frequency also of feeding on millipeds the nestling lags behind its parent. About 52 per cent of the nestling starlings were fed on millipeds, while fully 78 per cent of the adults had taken such food during the same time. It would seem, then, that the parent birds in their search for food for the young either deliberately pass up many a milliped or else devour them themselves as they proceed.

Nothing of importance appeared in the remaining miscellaneous animal matter, which formed less than 1 per cent of the food.

### VEGETABLE FOOD.

Of the vegetable food consumed, cultivated cherries are the only item of importance. This fruit was eaten by 30 of the 325 nestlings collected and formed 3.18 per cent of the food, as compared with 8.01 per cent for adults during the same period. Most of the cherries eaten by the nestlings are brought to them the last few days they are in the nest, when they have acquired a dietary very similar to that of their parents. During this short time, however, a hungry brood of 5 or 6 can make away with considerable fruit. A nest box which had been occupied by only one brood near Closter, N. J., con-

tained 114 stones of cultivated cherries when cleaned on July 11. The economic significance of the starling's taste for cherries is fully discussed under the food of the adults, on pages 26 to 28.

The remaining vegetable food, less than 2 per cent, is composed largely of rubbish. Mere traces of corn, oats, and wheat were present in a few stomachs.

### FOOD PREFERENCES AT DIFFERENT AGES.

In order to reveal the changes that take place in the food preferences of the nestling starling from the time it receives its first meal to the time it is ready to leave the nest and shift for itself, the nestlings' stomachs were arranged in three groups, representing as nearly as possible the first, second, and third periods of nestling life. These groups include, approximately, (1) birds from 1 to 5 days old; (2) those 6 to 10 days old; and (3) all above 10 days of age. Each group was well represented, there being 79, 94, and 122 stomachs, respectively. Fourteen additional nestling stomachs on hand could not be used, as definite data concerning their age was lacking. The information derived from the regrouping of this material is presented in condensed form in Table III and graphically represented in figure 3.

TABLE III.—*Monthly percentages of various kinds of food eaten by nestling starlings, showing the changing character at different ages (see fig. 3).*

| Age of nestlings. | Ground beetles. | May beetles, etc. | Weevils. | Grasshoppers and crickets. | Caterpillars. | Millipeds. | Spiders. | Miscellaneous animal matter. | Cherries. | Miscellaneous vegetable matter. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 to 5 days | 2.43 | 3.91 | 5.59 | 13.96 | 45.26 | 1.48 | 23.44 | 2.98 | 0.18 | 0.77 |
| 6 to 10 days | 11.59 | 18.33 | 4.49 | 11.23 | 34.88 | 5.34 | 3.57 | 5.93 | 3.36 | 1.28 |
| 10 or more days | 7.69 | 18.25 | 1.02 | 8.98 | 37.81 | 6.38 | 3.28 | 7.61 | 4.76 | 4.22 |

It will be noticed that as the bird grows older there is a decrease in its consumption of soft and easily digested foods. The bulk of spiders eaten, for instance, is confined to the first few days of the bird's life. In the case of caterpillars the decrease is not uniform, although it is apparent that the very young birds are fed more than those a little older. There is also a grádual lessening in the quantity of crickets and grasshoppers taken. Under the heading "weevils" a similar decrease is recorded, but instead of the hard-shelled adults being so popular with young starlings, it is the larvæ of the clover leaf weevil which forms the bulk of the food. In the case of ground beetles and May beetles, as well as with millipeds, the younger nestlings are given smaller quantities. The same is true for the principal vegetable item, cultivated cherries. Only two of the 79 starlings less than 6 days old had been fed such fruit.

From the foregoing detailed account of the food of nestling starlings and the comparisons made with the food habits of the parent birds at the same time of year, it is apparent that the habits of the young materially raise the starling's economic status in the early summer months. In the consumption of destructive caterpillars, crickets and grasshoppers, and scarabæid beetles, three of the favorite food items of starlings, the young birds excel, and in the destruc-

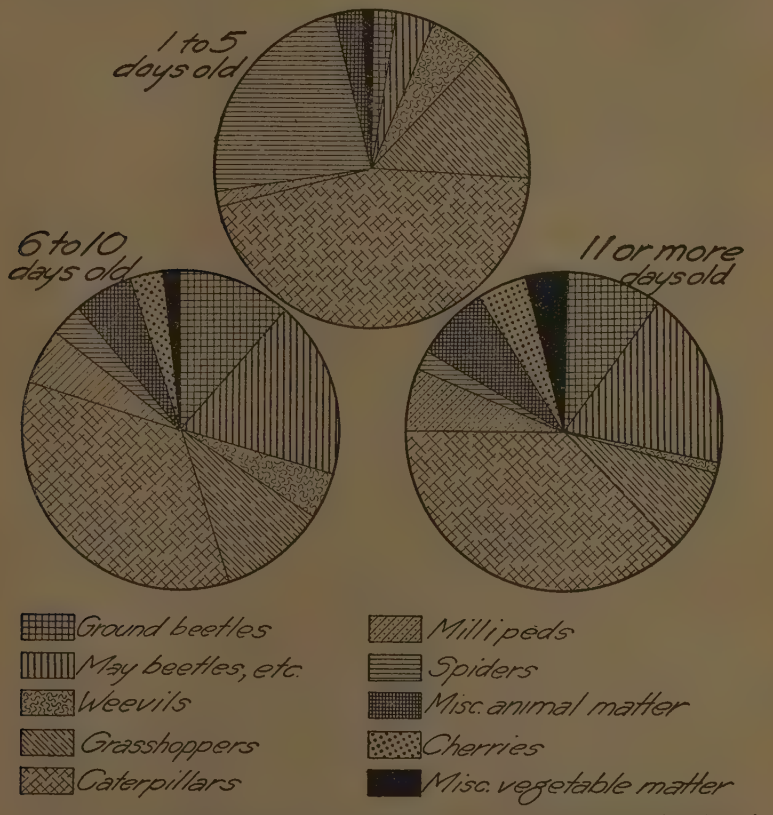


FIG. 3.—Chart of food of 295 nestling starlings, showing its changing character during the three stages of nestling life. In Table III, page 44, the same information is presented in percentages. Explanatory remarks on both chart and table are given on page 44.

tion of beneficial ground beetles and cultivated cherries they are not so culpable as their parents. Correlated with this demonstrated superiority in food habits are the facts that, bird for bird, nestlings consume more food than adults and that in the case of the starling they outnumber the adults two to one. Confronted with such an array of favorable testimony the worth of the young starling can be scarcely overestimated.

## RELATION TO OTHER SPECIES OF BIRDS.

The antagonism between starlings and other birds constitutes one of the most frequently heard complaints against this species. This is especially true in thickly settled regions where the natural nesting sites of hole-nesting birds have been largely replaced with artificial ones in the form of bird boxes. This fact in itself has a tendency to bring to human attention most of such conflicts, as many of the bird boxes are in dooryards where they are under more or less constant observation. It must also be borne in mind that the driving out of native species which have been induced by enthusiastic bird lovers to take up sites in the dooryard, will be more keenly felt than the molesting of breeding birds at a greater distance from the house and with which there has been less intimate acquaintance.

While particular attention was given to this complaint during the breeding season, little antagonism was actually observed. However, as acts of vandalism last for just a moment or two, it is not surprising that more instances were not noted. It is apparent, then, from the nature of the case that data of this kind must be secured largely from the notes of reliable observers. Those who have had the fortune to witness such activities report that bluebirds and flickers suffer most, but martins, house wrens, robins, English sparrows, and a few other wild species, as well as domestic pigeons, are also bothered in their nesting operations.

Unrelenting perseverence dominates the starling's activities when engaged in a controversy over a nesting site. More of its battles are won by dogged persistence in annoying its victim than by bold aggression, and its irritating tactics are sometimes carried to such a point that it seems almost as if the bird were actuated more by a morbid pleasure of annoying its neighbors than by any necessity arising from a scarcity of nesting sites. Illustrative of this are the experiences of a pair of bluebirds observed at Norwalk, Conn., building a nest in a cavity high in an elm tree. On April 8 two starlings were seen sitting nearby, whistling and squealing. They were not noted attacking the bluebirds, but the next afternoon the bluebirds had disappeared and the starlings were carrying nest material into the cavity. The next day the bluebirds tried to get into a wren box having an opening too small for their passage. A day or two later four bird boxes were erected in the vicinity, and the bluebirds promptly began to build in one. This apparently aroused the displeasure of the starlings; so they entered the box and removed the nest material. The same performance was repeated at two of the other boxes, and it was not until the bluebirds had taken up the last box, which was provided with a 1⅝-inch opening, through which the starlings could not pass, that they were able to lay a set of eggs. That misfortune

still attended the bluebirds was disclosed one morning when the male was found dead beneath the nest and the eggs were deserted by the female. There was no evidence, however, to connect the starlings with the final disaster. Additional reliable evidence of bluebirds being driven out by starlings was secured at Norwalk, Wilton, and West Cornwall, Conn.; Groton, Mass.; Medford, Long Island, N. Y.; and Adelphia, N. J.

In contrast with such actions was the situation presented in an orchard at Norfolk, Conn., not far from the scene just described. Here a pair of bluebirds and two pairs of starlings conducted their family affairs peaceably in close proximity to each other. At Hartford, Conn., a pair of bluebirds and three pairs of starlings nested in natural cavities in apple trees located in two adjacent city lots. The owner of the property said he had watched the birds closely and did not see any evidence of antagonism between the species.

In contests with the flicker the starling frequently makes up in numbers what disadvantage it may have in size. Typical of such combats was the one observed on May 9, at Hartford, Conn., where a group of starlings and a flicker were in controversy over a newly excavated nest. The number of starlings varied, but as many as 6 were noted at one time. Attention was first attracted to the dispute by a number of starlings in close proximity to the hole and by the sounds of a tussle within. Presently a flicker came out dragging a starling after him. The starling continued the battle outside long enough to allow one of its comrades to slip into the nest. Of course the flicker had to repeat the entire performance. He did this for about half an hour, when he gave up, leaving the starlings in possession of the nest.

On June 19, at Port Chester, N. Y., a controversy was observed between a pair of starlings and a pair of flickers, whose brood was about to leave the nest, which was about 30 feet from the ground and within 25 feet of a house. When first observed one of the starlings was perched a few feet from the nest, in the entrance to which was one of the flickers. Whenever this flicker relaxed its vigilance for a moment one of the starlings would immediately make a dart for the nest opening. A scuffle would ensue in which both flicker and starling would come tumbling to the ground and a few feathers would fly. In the meantime the other flicker and starling would take up the waiting game in the tree top. This condition had prevailed for several days, and after a day or two more of continuous conflict the flicker succeeded in bringing forth its brood unharmed. The nest cavity was not then taken over by the starlings.

At Gwynedd Valley, Pa., an observer told of the killing of two broods of young flickers hatched in a tree in his dooryard. He had prevented the starlings from nesting in this cavity by repeated shoot-

ing early in spring, but was unable to prevent the destruction of the young flickers, which were killed by being dragged from the nest and dropped to the ground. At Closter, N. J., a similar conflict was reported in 1915, but in the following year the tables were reversed, for, in a dispute over a nest box only a few rods from the site of the flicker tragedy of the former year, a starling engaged in a struggle for a nest box met its death, apparently in a battle with a flicker. That less serious outcomes sometimes result from starling-flicker feuds was indicated by circumstantial evidence at a point near Hopewell Junction, N. Y. A brood of starlings was occupying a nest cavity recently excavated by flickers in accordance with the approved principles of flicker architecture, the entrance being on the lower side of the limb, protected from drainage. In a neighboring tree was found a brood of 6 half-grown flickers located in a natural cavity, similar to ones often chosen by starlings, a hollow limb with the entrance exposed upwards and with an opening full 5 inches in diameter. All circumstances seemed to indicate that the birds had simply exchanged nesting sites. Additional reliable evidence of the starling's aggressive tactics against flickers, some of which involved the killing of young as well as the usurping of nest sites, came in reports from Hartford, Norwalk (2), West Cornwall, and Portland, Conn.; Woodstown and Adelphia, N. J.; and Ambler and Maple Glen, Pa.

Purple martins suffer to only a limited extent from the starling's demand for nest sites. Throughout Connecticut and much of northeastern New Jersey the martin is not an abundant bird, so while houses put up for martins in various localities were usually occupied by starlings and English sparrows, there was little chance of their having been tenanted with martins, even had they not been occupied by the foreigners. One martin house at Norwalk, Conn., was occupied by a pair of sparrow hawks on one side and three pairs of starlings on the other. At Hadlyme, Conn., a colony of fully 50 pairs of martins conducted unmolested their nesting operations under the close scrutiny of starlings that nested near by. An observer from Adelphia, N. J., reported that he had witnessed an attack on martins in his yard. He had erected two martin houses of four compartments each early in the year. One was occupied by starlings, and when a pair of martins appeared and attempted to take up the other abode a fight occurred. A starling was observed going into the martin house, and after pulling out one of the inmates dragged out the nest material. The martin was subsequently attacked whenever it approached and it finally left the premises. In this and in another case at Adelphia the martins had come to the boxes for the first time.

The two most specific reports received, bearing on the relation of starlings to wrens, are conflicting. In one, at Norwalk, Conn., a pair of starlings flew to a wren's nest, and pulled the bird out and

killed it; while in the other, at Ambler, Pa., 11 pairs of wrens nested in peace in a yard of about an acre, although starlings were common in the breeding season.

The single record of starlings attacking a red-headed woodpecker comes from Baltimore, Md., where a combat was observed over a nest cavity in a telephone pole.

That the aggressions of starlings are not entirely restricted to attacks on hole-nesting species is apparent from the fact that after bluebirds and flickers, robins seem to be the birds most frequently molested. Although no observation of this kind was made by the investigators, reliable evidence has come from outside sources. At Ambler, Pa., two nestling robins were killed by starlings, the victims being dispatched by powerful pecks on the head. At East Norwalk, Conn., a starling was seen to peck and break all the eggs in a robin's nest. At the bird sanctuary at Fairfield, Conn., the remains of a robin's nest destroyed by starlings was seen, the caretaker witnessing this act of vandalism; after the robins had rebuilt the structure it was again destroyed, presumably by starlings. Other corroborative evidence on this point was secured at Gwynedd and Spring House, Pa.; Adelphia, N. J.; Southampton, N. Y.; and Hadlyme, Conn. Single attacks on a Baltimore oriole's nest and the young of a chipping sparrow were reported.

It was an almost universal observation throughout Connecticut and New Jersey that the English sparrow is decreasing in numbers, and many persons attribute this to the starling. No belligerent acts between these two species, however, were witnessed in the field, though several instances of the usurping of the nesting or roosting places of English sparrows by starlings have been reported. In a number of cases these two species were observed breeding in close proximity, and under one water tank their nests almost touched.

A few instances of starlings attacking domestic pigeons were reported. At Middletown, R. I., it was found necessary to wage constant warfare on the starlings to keep them from nesting in one pigeon loft, where they appropriated for their own domestic affairs the boxes put up for the pigeons. They carried in so much material that they filled the boxes and on one or two occasions dragged it in so rapidly as actually to barricade the setting pigeons, which were entirely unresisting. At Closter, N. J., it was reported that starlings had entered a pigeon loft, driven out the adults, and then, dragging out the squabs, had let them fall to the ground, where they were killed. Opposing testimony was presented from experiences on a squab farm at Stanton, N. J. Here the starlings nested peaceably along with the pigeons and the only trouble that the latter had occurred during cold weather, when starlings in considerable numbers used the coops

for roosting places. Whenever a lantern was brought into the building at night the starlings flew about in great commotion and, frightening the pigeons, caused some of the setting birds to leave their eggs. Starlings were reported on occasions to have driven pigeons even from church towers. At Norwalk, Conn., and Newburgh, N. Y., however, towers were found where pigeons were successfully raising young in the immediate presence of roosting starlings.

To determine whether a mere scarcity of nesting sites is the cause of the antagonism between starlings and other species, 24 nest boxes were erected, 12 in the vicinity of Closter, N. J., and 12 about Norwalk, Conn. These boxes were of a size commonly provided for flickers, measuring approximately $4\frac{3}{4}$ by $5\frac{3}{4}$ by 16 inches (interior dimensions) and fitted with a $2\frac{1}{2}$-inch hole, and so constructed that the nests could be readily inspected by means of a removable front. In some of these boxes the size of the hole was reduced by tacking on the front small boards containing circular openings, some $1\frac{3}{4}$ inches and some $1\frac{5}{8}$ inches in diameter. These were used to determine the smallest opening through which a starling can pass. The boxes were occupied readily both by starlings and bluebirds; in most cases this was not due to a lack of natural nesting sites, as there were many to be had. In one orchard a pair of starlings showed such a marked preference for a natural cavity that they raised two broods therein, although 3 boxes were in the immediate vicinity, unoccupied at the time their nest was started. Following is a summary of what transpired at the 24 boxes:

Four boxes failed to have any bird activity connected with them; 18 had starling nests started; 14 had starling nests completed; 10 had starling eggs hatched (in 3 other instances the eggs were removed); 8 had bluebird nests started, four of which produced young; and 1 had a completed nest of house wrens.

None of the 6 boxes with $1\frac{5}{8}$-inch opening was occupied by starlings; 5 of 7 boxes with $1\frac{3}{4}$-inch opening were occupied by starlings; 10 of 13 boxes with $2\frac{1}{2}$-inch opening were similarly occupied; and at 3 boxes bluebirds were driven away by starlings.

In summarizing the evidence bearing on the relation between the starling and our native birds during the breeding season, it is apparent that the bluebird and flicker suffer most. Both have no doubt to a certain extent been driven away from the vicinity of the dooryard. Regarding the seriousness of these attacks and the ultimate consequences to the population of the species it is believed the fears of many bird lovers are exaggerated. While instances such as those cited are numerous and often have resulted fatally to the birds attacked it must be borne in mind that this information is the compilation of more than six months' constant investigation, during which time

no opportunity to secure data on this point was overlooked. Bluebirds are common and generally distributed in the sections thickly settled with starlings, and although observers have noted their disappearance in small areas confined to a dooryard or two, it is the opinion of those who are qualified to judge the general abundance of these birds that in Connecticut and northeastern New Jersey bluebirds have either held their own or increased in numbers in the last few years. Since bluebirds will continue to nest commonly in localities away from human habitation where they have little to fear from starlings, and since even in the dooryard, their nests, eggs, and young may be protected by providing nest boxes having an opening no greater than 1½ inches in diameter, there is little danger of the race as a whole being placed in jeopardy.

The flicker also will be driven from the vicinity of houses, but it, too, will always find a refuge in wilder situations to which the starling seldom goes. In those parts of Connecticut, New York, and New Jersey where the starling has been a common bird and in competition with the flicker for at least 15 years the latter still maintains as conspicuous a place in the bird world as it does in other parts of these States where the starling is not yet common. The same can be said of the robin, which in northeastern New Jersey and along the Connecticut shore is an extremely abundant bird. Martins are more abundant in western, central, and southern New Jersey than in the center of starling population, but such a condition of relative abundance existed before the advent of the starling, and it can not be construed as a result of starling aggression. Neither can the apparent decrease in the English sparrow population throughout New Jersey and parts of New England in the last 10 years be correlated with the spread of the starling, as in many sections where the decrease of the sparrow has been noted the starling has not yet arrived in numbers. As for the other species at present known to be attacked by starlings, the acts of vandalism are so occasional that the effect is negligible and the situation is by no means as serious as that presented by the predatory habits of the blue jay, the grackle, or the crow.

A consideration of the economic significance of displacing certain native species by the starling involves judgment of the relative worth of the various species. A comparison of the merits of the starling with those of its breeding competitors reveals that it is certainly more valuable than the robin, flicker, or English sparrow; that it has food habits fully as favorable as those of the house wren; and that the bluebird and martin are the only species with which the starling is in intimate competition whose economic worth might be considered greater than that of the starling.

Field observation sheds some light on the added competition for food imposed upon native species by the presence of the starling. During the breeding season, robins in suburban sections and meadowlarks in the more open country are the species thrown most intimately in contact with the newcomer. The robin finds its customary supply of cutworms in the garden reduced by the diligent search of the starling; earthworms, a favorite food of the robin in wet weather, also are taken by the starling, but the supply of these appears to be ample for both. In the case of the meadowlark, such items as cutworms, clover leaf weevils, and other beetles constitute the food supply most frequently sought by both species.

After the breeding season the starling comes in competition with several additional species in its search for food. In feeding on meadow and pasture land, its closest associate is the cowbird, and a mixed flock of these two species is a common sight about dairy herds. Contrary to expectation, however, the food habits of the two do not seriously conflict at that time of year. A comparison of the stomach contents of cowbirds and starlings secured from the same flocks showed that while starlings were feeding most heavily on grasshoppers and crickets, cowbirds were satisfying themselves largely by picking up seeds of ragweed and foxtail grass. Similar conditions existed in mixed flocks of starlings, red-winged blackbirds, and grackles roaming through cornfields. Ripening corn formed the major portion of the food of the red-wings and grackles, while starlings ate comparatively little. Probably the greatest influence exerted by the starling on the food supply of other birds is occasioned by its consumption of wild fruit during late summer and early fall. Wild cherry and sour gum trees heavily laden with fruit are soon stripped when a flock of several hundred starlings feeds continually in the vicinity, and, although the total supply of this food is enormous, instances were observed where locally such birds as robins, catbirds, and cedar waxwings were compelled to seek other sources of food. During winter starlings secure a certain portion of the food formerly eaten by English sparrows, especially about dumping grounds of cities. Where bird lovers have taken pains to attract native species they have often found the foreigner greedily consuming all the food they could supply, with the result that the cost of attracting birds rose almost to a prohibitive point.

Here again must judgment be given on the relative worth of the species concerned before the seriousness of the starling's consumption of the former food supply of other birds can be understood. After carefully weighing all the evidence available, it is safe to state that in the area covered by this investigation the starling is economically the superior of the robin, the catbird, the red-wing, the grackle, the

cowbird, or the English sparrow, and that in this competition for food the meadowlark is the only species whose added difficulty in sustaining itself is to be deplored.

## NATURAL ENEMIES.

Very little evidence is at hand regarding the natural enemies of the starling. At Norwalk, Conn., a cat was seen carrying a freshly caught fledgling; and it is probable that a number are thus captured, as cats are numerous in the whole region. Far more robins, catbirds, and other birds are destroyed in this manner, however, for starlings are better protected in the nest and are also able to fly better when they leave the nest than are many of our common native birds.

Hawks were several times noted flying with or about flocks of starlings without attempting to capture any of them. At Bay Shore, N. Y., a curious performance was noted on three successive afternoons. A pair of sparrow hawks used the dead tops of several large locust trees as a lookout point for their hunting. Late in the afternoons the starlings appeared in this locality on their way to roost. As they passed, the sparrow hawks darted out, apparently in pursuit, but they never struck a bird. Instead, both the starling flock and sparrow hawks went through a series of intricate evolutions, apparently alternating in the rôle of pursuer and pursued. Occasionally the performance would be varied by a starling swooping down on a hawk as it perched on a limb, driving it off: then followed the same evolutions as when the hawk was the aggressor.

At Freehold, N. J., a sharp-shinned hawk was seen diving into a tree full of young starlings, but the latter, rushing to the center of the thick foliage, escaped harm. At Glen Cove, N. Y., a Cooper hawk was observed to dart from a tree into a passing flock of starlings and, striking one, to carry it away. A young starling was found also in a nest of a Cooper hawk at Wilton, Conn. These instances are enough to show that the birds of prey have learned to take their toll from the newcomer, but give little basis for any estimate as to their effect in checking its increase and spread.

Many of the starlings collected were heavily infested with intestinal parasites, but no evidence was secured as to the effect these might have on the mortality of the birds.

Cold weather seems to have some effect in checking the increase of starlings as in the vicinity of winter roosts it is common to find dead birds. This is particularly true in northern New Jersey, the region of their greatest abundance.

## ERADICATION OF ROOSTS.

Soon after the first brood of starlings begins to leave the nest, sometimes as early as the middle of June, one may find these birds resorting to nightly roosts (see pp. 11–13). These may be in trees or in church towers, barn cupolas, sheds, etc.; but up to the advent of cold weather the greatest number of starlings gather in tree roosts. Frequently these are established in the residential sections of cities, where the noise in the evening and early morning, with the attendant filth and odor from their droppings, makes the starlings most unwelcome birds. But by no means all of the nuisance should be attributed to starlings, as in most roosts of any size grackles, robins, English sparrows, cowbirds, red-winged blackbirds, and even purple martins help to swell the numbers. Plainfield, Newark, Orange, Montclair, and Glen Ridge, N. J.; Greenwich, Fairfield, and Hartford, Conn.; Glen Cove, N. Y.; and Germantown and Ambler, Pa., are a few of the places where roosts, in which starlings formed a large part of the assemblage, have proved to be a distinct nuisance.

The roost encountered at Orange, N. J., is a typical one. Here, as in many other instances, the birds had selected tall elms and maples overhanging roadways and dooryards. When visited on July 15, 1916, the ground beneath the larger trees was whitened with excrement. Feathers from the molting birds and the bodies of those that had died littered the ground, and the offensive odor arising, especially in humid weather, permeated the whole neighborhood.

This roost was occupied by starlings, grackles, and a few hundred robins. Observations made on the incoming birds indicated that the ratio between the number of starlings and grackles was about 3 to 2. During the early evening starlings greatly predominated, but as darkness deepened the proportion of grackles increased, while the last to enter the roost were robins. On July 17, during four minutes at the height of the influx (6.56 to 7 p. m.) 900 birds entered the roost from the south, and on the following night, during a period of 38 minutes, 3,100 were noted coming from the same direction. From these and other observations it was estimated that the roost was occupied by from 6,000 to 8,000 birds. During the entire process of assembling, the birds that were already gathered kept up an incessant din—the starlings with their variety of whistles and rasping notes and the grackles with their monotonous "checks" and unmusical squeaking calls. The clamor gradually lessened as darkness came, but a few of the birds might be heard at odd times all through the night. At the peep of day the gathered thousands would break out with a volume of song that terminated abruptly the slumbers of all light sleepers in the vicinity. This accomplished, the birds would depart rather suddenly on their daily search for food.

In previous years residents of the vicinity had undertaken measures, more or less feeble, to remove the objectionable birds. Some of these afforded temporary relief. Roman candles shot on one or two nights drove the birds away for a short time. Three incandescent lamps placed in a tree in the center of the roost gave relief to that immediate vicinity. The ringing of a bell placed in another tree served to drive away the birds in the early morning hours and shorten their annoying daybreak serenade, and a little desultory shooting also had been done, but with no lasting results.

Operations with a view of testing some of these methods of roost eradication were begun on July 17, at the Orange roost. A shotgun was used in the early evening, and when darkness arrived a number of Roman candles were discharged. Five successive nights of attack removed the roost. During these operations two observations of importance in connection with roost eradication were made. One was that the firing of a gun early in the evening, just as the birds are coming to roost, makes a more effective impression than one fired after the colony has settled for the night. When there is still daylight the frightened birds will fly for some distance before alighting, while later in the evening the birds move only a few yards from their former perch. It was also noted that in a mixed roost adult starlings were the first to take flight and young starlings were next to leave; grackles were less easily driven away, while robins were practically fearless, few of them leaving the roost even after five nights of attack. The relief obtained, however, was but temporary. In about 10 days the birds, not being further molested, reoccupied the roost. On August 24, a second attempt was made to drive them out, and after 6 nights' shooting they left, not to return that season.

On the last 6 nights of September a starling-grackle-robin roost at Freehold, N. J., was attacked with the shotgun only and completely removed. The birds apparently chose a new roosting place at some distance from Freehold, for when the roost had been eradicated, comparatively few starlings could be found in the daytime anywhere in the country surrounding the town, where previously they had been common.

A single night's shooting at a roost composed entirely of starlings at Fairfield, Conn., during which 40 of the birds were killed, gave the desired results.

A roost at Montclair, N. J., had been a source of considerable trouble for several years and measures had been taken to eradicate it. Roman candles had no effect, but four men using shotguns loaded with blank cartridges for three consecutive nights succeeded in driving the birds away. However, they moved to a point in Glen Ridge, N. J., where they became equally troublesome.

Experiments were made by the municipal authorities of Montclair in 1916 to determine the usefulness of a sticky substance applied to the branches of the trees of the roost. This had no apparent effect in deterring the birds, although six or seven trees near the center of the roost had their branches well smeared with it. The sticky, resinous gum used was applied with small paddles, the climbers using a boatswain's chair to reach the upper and outer branches. As in several other cases the shotgun had to be used to bring relief.

At Hartford, Conn., several years ago, a roost of about 5,000 starlings and grackles was established on one of the principal residential streets, where it became such a nuisance that the city authorities took measures to remove it. Objection to the use of a shotgun was made by local bird lovers, who volunteered to drive the birds away by firing Roman candles. Three nights' work, in which from 3 to 15 men armed with Roman candles participated, removed the roost.

From present experiences it is apparent that neither the shotgun nor the Roman candle, however, effects a lasting cure. Each one, when used persistently, has served to remove roosts, but in either case vigilance must be used to prevent the birds from reestablishing themselves. In a few instances, as at Hartford, Roman candles did the work effectively, but at other roosts such measures have failed. A shotgun loaded with black powder shells, fired on 5 or 6 consecutive evenings, will give more certain results. Such treatment can be recommended for eradicating tree roosts of starlings and grackles wherever State and local laws permit.

Starling roosts located in church towers, where they have sometimes become a nuisance on account of the attending filth, can be abolished by the use of wire screen of a mesh of 1¼ inches or less. This method is almost universally resorted to in places thickly populated with starlings.

## CONTROL MEASURES.

Outside of the work done on roosts and the activities of caretakers of a few bird preserves, few efforts toward reducing the numbers of starlings have been made, but mention of some of these may be useful to those desiring to control the birds where they are injurious either to crops or buildings.

One fact connected with the behavior of starlings brought out repeatedly in field work is that the birds are easily frightened by gunfire and soon become exceedingly wary. A few gunshots are usually sufficient to drive them away from the vicinity of crops upon which they are feeding. This is especially true when they are eating cherries.

Where starlings become objectionable about dooryards by reason of the filth connected with their breeding operations, their activities

may be curtailed by closing all cavities which might be used for nests, or reducing the diameter of the entrances to 1¼ inches or less.

While wholesale destruction of these birds, where extermination of the species in this country is the object sought, can not be recommended, occasion may arise where local overabundance will accentuate some of the injurious habits of the species, and make a reasonable reduction in their numbers justifiable. Raids on their fall and winter roosts appear to be effective means of accomplishing this. In church towers, especially, large numbers may be easily captured at night. No poisoning method appears practicable in winter, but trapping has met with moderate success on bird preserves. An ordinary screen ash-shifter propped up on one side with a stick was used to advantage in one case, and after baiting the area below it, the trap was sprung by pulling a string attached to the supporting stick.

## LEGISLATION.

The popular attitude toward the starling has been reflected in State game laws. In all States where the bird is present even in moderate numbers it has been placed in the list of exceptions to protection. These States are Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland. In Maine, where, in the extreme southwestern corner, a few starlings have appeared, these birds have been given protection, subject, however, to a provision in the State game laws whereby any birds or mammals (save beavers) may be killed when destroying crops.

## SUMMARY OF EVIDENCE.

### FOOD HABITS.

The food habits of a bird are of paramount importance in determining its desirability, and in the case of the starling knowledge on this subject is available from evidence revealed from a larger series of stomachs apparently than any heretofore used in the investigation of the food habits of a single species, supported by extensive field observation in areas in this country where the species is most abundant. Following are the more important findings:

As an effective destroyer of terrestrial insects, including such pests as cutworms, grasshoppers, and weevils, the starling has few equals among the bird population of the northeastern United States.

The most serious objection to the starling on economic grounds arises from its destruction of cherries. When its work is combined with that of the robin, which is fully as destructive and much less easily frightened, the chances for a successful crop of cherries, especially of early varieties, are poor.

The starling's work on apples is confined largely to isolated trees and to small, old orchards. Late varieties suffer more than those which mature at a time when there is still a great abundance of wild black cherries available. In the aggregate the apple damage is not great and is practically absent in young, well kept, productive orchards. Injury to peaches and pears is negligible, and the damage to grapes is at present confined to small arbors—the large vineyards suffering very little.

Contrary to the opinion of many farmers, especially in New Jersey, the starling secures an extremely small portion of its sustenance from either sweet or field corn. Its association with the actual depredators of cornfields, the red-winged blackbirds and grackles, accounts for its reputation. It is true that the starling, especially in the vicinity of roosts, does inflict some damage on corn, but compared with that done by the other species named this is very little. Its damage to small grain is negligible.

In the small city or suburban garden the starling's fondness for green stuff in spring and early summer has been the cause of some complaint, but in large truck-crop sections, where the bulk of such produce is raised, the aggregate loss is trivial.

An idea of the economic significance of the starling's food habits is gained by comparison with the food habits of certain well-known native birds, with some of which it frequently associates. A thorough consideration of the evidence at hand indicates that, based on food habits, the adult starling is the economic superior of the robin, catbird, flicker, red-winged blackbird, or grackle. It is primarily a feeder on insects and wild fruit—less than 6 per cent of its yearly food being secured from cultivated crops. What damage it does inflict is due not so much to the character of its food habits as to the fact that the flocking habit has allowed some minor trait to be emphasized to a point where local damage results. The decidedly beneficial character of the food habits of one, two, or sometimes three broods of nestlings, numbering 4 to 6 to the nest, adds materially to the favorable economic status of the species.

### RELATION TO OTHER SPECIES.

While the advent of the starling doubtless has had some effect on native species nesting in the dooryard, it is not believed this bird will jeopardize any species as a whole. Economically considered, the starling is the superior of either the flicker, the robin, or the English sparrow, three of the species with which it comes in contact in its breeding operations. The eggs and young of bluebirds and wrens may be protected by the use of nest boxes with circular openings 1½ inches or less in diameter. This leaves the purple martin the only species readily subject to attack by the starling,

whose economic worth may be considered greater than that of the latter, but in no case was the disturbance of a well-established colony of martins noted. In its search for food the starling also comes in competition with neighboring species, most of which, however, are the starling's economic inferiors. The meadowlark appears to be the only species which might be affected by this competition for food whose added difficulty in sustaining itself is to be deplored.

### ROOSTS.

The objectionable habit possessed by the starling in common with several other species, particularly grackles and robins, of congregating in enormous roosts, usually in the residential section of a city, is, next to the damage resulting from the bird's food habits, the source of the greatest economic loss. The persistent use of firearms or Roman candles will remove these nuisances, but vigilance must be employed to prevent the reestablishing of the roosts in other places where they would be equally objectionable.

## CONCLUSION.

It has been the purpose of this investigation to determine what should be our attitude toward the starling, in order that a correct judgment might be reflected by legislation governing the protection of the bird. Most of the starling's food habits have been demonstrated to be either beneficial to man or of a neutral character. Furthermore, it has been found that the time the bird spends in destroying crops or in molesting other birds is extremely short compared with the endless hours it spends searching for insects or feeding on wild fruits. Nevertheless, no policy would be sound which would give the bird absolute protection and afford no relief to the farmer whose crops are threatened by a local overabundance of the species. Consequently, the enactment of laws that afford protection to the starling, except when it is actually doing or threatening to inflict damage, appears to be the wisest procedure. With its ready ability to adapt itself to new environments, the starling possesses almost unlimited capacity for good, but it is potentially harmful in that its gregarious habits may abnormally emphasize some minor food habit which would be indulged in at the expense of growing crops. The individual farmer will be well rewarded by allowing a reasonable number of starlings to conduct their nesting operations on the farm. Later in the season a little vigilance will prevent these easily frightened birds from exacting an unfair toll for services rendered.

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found.*[1]

ANIMAL MATTER.

| COLEOPTERA (GENUINA) (BEETLES). | |
|---|---|
| Unidentified adults | 106 |
| Unidentified larvæ | 137 |
| Cicindelidæ (tiger beetles): | |
| Cicindela purpurea | 1 |
| Cicindela repanda | 1 |
| Cicindela punctulata | 9 |
| Cicindela sp. | 20 |
| Cicindela sp., larvæ | 1 |
| Carabidæ (ground beetles): | |
| Unidentified | 729 |
| Unidentified larvæ | 3 |
| Omophron americanum | 1 |
| Carabus sylvosus | 1 |
| Carabus serratus | 4 |
| Carabus vinctus | 12 |
| Carabus nemoralis | 2 |
| Carabus sp. | 11 |
| Calosoma sayi | 1 |
| Calosoma calidum | 19 |
| Calosoma sp. | 8 |
| Elaphrus fuliginosus | 1 |
| Elaphrus sp. | 1 |
| Scarites subterraneus | 22 |
| Scarites sp. | 2 |
| Bembidium versicolor | 2 |
| Bembidium quadrimaculatum | 1 |
| Bembidium sp. | 3 |
| Patrobus longicornis | 2 |
| Pterostichus sayi | 4 |
| Pterostichus lucublandus | 121 |
| Pterostichus patruelis | 2 |
| Pterostichus sp. | 83 |
| Evarthrus sigillatus | 3 |
| Evarthrus sp. | 2 |
| Amara avida | 3 |
| Amara pennsylvanica | 21 |
| Amara impuncticollis | 1 |
| Amara basillaris | 3 |
| Amara fallax | 1 |
| Amara musculus | 2 |
| Amara sp. | 131 |
| Dicælus elongatus | 1 |
| Dicælus sp. | 20 |
| Platynus cupripennis | 46 |
| Platynus nutans | 1 |
| Platynus placidus | 1 |
| Platynus crenistriatus | 9 |
| Platynus sp. | 15 |
| Casnonia pennsylvanica | 38 |
| Casnonia sp. | 32 |
| Galerita janus | 1 |
| Galerita sp. | 4 |
| Lebia grandis | 1 |
| Lebia sp. | 1 |
| Cymindis pilosa | 8 |
| Cymindis sp. | 9 |
| Chlaenius tricolor | 2 |
| Chlaenius tomentosus | 72 |
| Chlaenius sp. | 103 |
| Anomoglossus emarginatus | 1 |

| COLEOPTERA—Continued. | |
|---|---|
| Carabidæ—Continued. | |
| Cratacanthus dubius | 11 |
| Agonoderus pallipes | 3 |
| Agonoderus testaceus | 1 |
| Agonoderus sp. | 5 |
| Harpalus dichrous | 1 |
| Harpalus erraticus | 1 |
| Harpalus caliginosus | 144 |
| Harpalus faunus | 9 |
| Harpalus pennsylvanicus | 82 |
| Harpalus compar | 18 |
| Harpalus erythropus | 6 |
| Harpalus herbivagus | 2 |
| Harpalus sp. | 318 |
| Selenophorus pedicularius | 1 |
| Stenolophus conjunctus | 5 |
| Stenolophus sp. | 2 |
| Anisodactylus rusticus | 89 |
| Anisodactylus carbonarius | 1 |
| Anisodactylus baltimorensis | 3 |
| Anisodactylus lugubris | 1 |
| Anisodactylus sp. | 224 |
| Dytiscidæ (predacious diving beetles): | |
| Agabus disintegratus | 1 |
| Hydrophilidæ (water scavenger beetles): | |
| Tropisternus glaber | 2 |
| Tropisternus sp. | 1 |
| Philhydrus sp. | 1 |
| Sphæridium scarabæoides | 21 |
| Cercyon unipunctatum | 1 |
| Cercyon sp. | 1 |
| Cryptopleurum minutum | 1 |
| Silphidæ (carrion beetles): | |
| Unidentified | 1 |
| Necrophorus sp. | 3 |
| Silpha surinamensis | 1 |
| Silpha noveboracensis | 3 |
| Silpha americana | 1 |
| Silpha sp. | 4 |
| Staphylinidæ (rove beetles): | |
| Unidentified | 155 |
| Quedius molochinus | 1 |
| Staphylinus maculosus | 29 |
| Staphylinus mysticus | 9 |
| Staphylinus sp. | 58 |
| Philonthus politus | 1 |
| Philonthus hepaticus | 1 |
| Philonthus fusiformis | 1 |
| Philonthus micans | 1 |
| Philonthus sp. | 14 |
| Stenus sp. | 3 |
| Cryptobium sp. | 2 |
| Hesperobium sp. | 1 |
| Pæderus littorarius | 2 |
| Scaphidiidæ (shining fungus beetles): | |
| Bæocera sp. | 1 |
| Coccinellidæ (ladybugs): | |
| Unidentified adults | 18 |
| Unidentified larvæ | 1 |
| Megilla maculata | 5 |

[1] A total of at least 494 specifically different food items have been found in the food of the starling.

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

ANIMAL MATTER—Continued.

| COLEOPTERA—Continued. | |
|---|---|
| Coccinellidæ—Continued. | |
| Hippodamia convergens | 4 |
| Hippodamia 13-punctata | 1 |
| Hippodamia parenthesis | 15 |
| Hippodamia sp | 3 |
| Coccinella 9-notata | 1 |
| [illegible] sp | 1 |
| Adalia bipunctata | 2 |
| Scymnus americanus | 1 |
| Erotylidæ (banded fungus beetles): | |
| Languria mozardi | 2 |
| Cucujidæ (flat bark beetles): | |
| Silvanus surinamensis | 3 |
| Histeridæ (shining carrion beetles): | |
| Unidentified | 28 |
| Hister biplagiatus | 1 |
| [illegible] | 1 |
| Hister interruptus var. immunis | 4 |
| Hister abbreviatus | 1 |
| Hister americanus | 5 |
| Hister perplexus | 1 |
| Hister subrotundus | 1 |
| Hister sp | 17 |
| Nitidulidæ (sap-feeding beetles): | |
| Ips quadriguttatus | 5 |
| Trogositidæ (grain and bark-gnawing beetles): | |
| Tenebrioides corticalis | 1 |
| Tenebrioides sp | 2 |
| Byrrhidæ (pill beetles): | |
| [illegible] | 63 |
| Cytilus sericeus | 1 |
| Cytilus sp | 4 |
| Byrrhus sp | 4 |
| Heteroceridæ (mud beetles): | |
| Heterocerus sp | 1 |
| Elateridæ (click beetles): | |
| Unidentified adults | 303 |
| Unidentified larvæ | 29 |
| Adelocera discoidea | 1 |
| Cryptohypnus abbreviatus | 2 |
| Monocrepidius lividus | 2 |
| Monocrepidius vespertinus | 9 |
| Monocrepidius auritus | 3 |
| Monocrepidius bellus | 13 |
| Monocrepidius sp | 11 |
| Drasterius elegans | 17 |
| Drasterius sp | 12 |
| Agriotes mancus | 4 |
| Agriotes pubescens | 1 |
| Agriotes sp | 1 |
| Melanotus sp | 5 |
| Limonius griseus | 10 |
| Limonius interstitialis | 1 |
| Limonius plebejus | 2 |
| Limonius sp | 7 |
| Corymbites pyrrhos | 1 |
| Asaphes memnonius | 1 |
| Buprestidæ (metallic wood-borers): | |
| Unidentified | 2 |
| Dicerca obscura | 1 |
| Dicerca lurida | 1 |

| COLEOPTERA—Continued. | |
|---|---|
| Lampyridæ (fireflies): | |
| Unidentified adults | 11 |
| Unidentified larvæ | 6 |
| Chauliognathus pennsylvanicus | 13 |
| Chauliognathus marginatus | 12 |
| Chauliognathus sp | 2 |
| Telephorus carolinus | 4 |
| Telephorus bilineatus | 4 |
| Telephorus sp | 5 |
| Polemius sp | 1 |
| Cleridæ (checkered beetles): | |
| Chariessa pilosa | 1 |
| Scarabæidæ (lamellicorn beetles): | |
| Unidentified adults | 104 |
| Unidentified larvæ | 34 |
| Canthon lævis | 2 |
| Canthon sp | 2 |
| Copris minutus | 1 |
| Copris tullius | 6 |
| Copris sp | 1 |
| Onthophagus nuchicornis | 9 |
| Onthophagus hecate | 9 |
| Onthophagus pennsylvanicus | 6 |
| Onthophagus sp | 6 |
| Atænius cognatus | 19 |
| Atænius sp | 8 |
| Aphodius fossor | 9 |
| Aphodius fimetarius | 106 |
| Aphodius granarius | 9 |
| Aphodius inquinatus | 16 |
| Aphodius stercorosus | 1 |
| Aphodius sp | 25 |
| Bolbocerosoma farctum | 2 |
| Odontaeus cornigerus | 1 |
| Geotrupes splendidus | 2 |
| Geotrupes sp | 1 |
| Dichelonycha elongata | 1 |
| Serica vespertina | 2 |
| Serica sp | 1 |
| Diplotaxis atlantis | 9 |
| Diplotaxis sp | 13 |
| Phyllophaga ephilida | 1 |
| Phyllophaga fusca | 30 |
| Phyllophaga anxia | 10 |
| Phyllophaga gibbosa | 13 |
| Phyllophaga micans | 4 |
| Phyllophaga fervida | 3 |
| Phyllophaga fraterna | 6 |
| Phyllophaga hirticula | 55 |
| Phyllophaga forsteri | 10 |
| Phyllophaga crenulata | 3 |
| Phyllophaga tristis | 41 |
| Phyllophaga sp | 162 |
| Anomala lucicola | 7 |
| Anomala sp | 31 |
| Cotalpa lanigera | 6 |
| Dyscinetus trachypygus | 1 |
| Ligyrus gibbosus | 10 |
| Ligyrus sp | 2 |
| Euphoria fulgida | 1 |
| Euphoria inda | 12 |
| Euphoria sp | 8 |

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

ANIMAL MATTER—Continued.

| COLEOPTERA—Continued. | |
|---|---|
| Cerambycidæ (long-horned beetles): | |
| Unidentified | 9 |
| Phymatodes variabilis | 1 |
| Monohammus scutellatus | 1 |
| Lepturges querci | 1 |
| Tetraopes canteriator | 1 |
| Tetraopes sp | 1 |
| Chrysomelidæ (leaf beetles): | |
| Unidentified | 311 |
| Donacia sp | 1 |
| Lema trilineata | 2 |
| Crioceris asparagi | 1 |
| Chlamys plicata | 6 |
| Chlamys sp | 1 |
| Bassareus sp | 1 |
| Cryptocephalus venustus | 8 |
| Cryptocephalus calidus | 2 |
| Cryptocephalus sp | 6 |
| Pachybrachys m-nigrum | 1 |
| Pachybrachys sp | 3 |
| Diachus auratus | 1 |
| Typophorus canellus | 3 |
| Typophorus quadrinotatus | 8 |
| Typophorus aterrimus | 2 |
| Typophorus gilvipes | 1 |
| Typophorus sp | 27 |
| Graphops pubescens | 3 |
| Graphops marcassitus | 3 |
| Graphops sp | 4 |
| Colaspis brunnea | 52 |
| Colaspis sp | 31 |
| Nodonota tristis | 1 |
| Nodonota puncticollis | 7 |
| Nodonota clypealis | 1 |
| Nodonota sp | 12 |
| Labidomera clivicollis | 1 |
| Leptinotarsa 10-lineata | 39 |
| Zygogramma suturalis | 17 |
| Zygogramma sp | 3 |
| Calligrapha similis | 10 |
| Calligrapha elegans | 7 |
| Calligrapha lunata | 2 |
| Calligrapha sp | 7 |
| Plagiodera viridis | 2 |
| Gastroidea polygoni | 2 |
| Gastroidea sp | 1 |
| Phyllobrotica sp | 1 |
| Diabrotica 12-punctata | 3 |
| Diabrotica vittata | 1 |
| Diabrotica sp | 2 |
| Trirhabda canadensis | 2 |
| Trirhabda sp | 1 |
| Galerucella americana | 10 |
| Galerucella sp | 63 |
| Monoxia puncticollis | 2 |
| Oedionychis vians | 2 |
| Oedionychis thoracica | 2 |
| Oedionychis fimbriata | 5 |
| Disonycha crenicollis | 1 |
| Disonycha caroliniana | 1 |
| Disonycha triangularis | 1 |
| Disonycha xanthomelaena | 2 |

| COLEOPTERA—Continued. | |
|---|---|
| Chrysomelidæ—Continued. | |
| Disonycha sp | 2 |
| Haltica ignita | 5 |
| Haltica rufa | 1 |
| Haltica sp | 1 |
| Systena hudsonias | 7 |
| Systena sp | 3 |
| Phyllotreta vittata | 1 |
| Phyllotreta armoraciae | 1 |
| Chaetocnema denticulata | 13 |
| Chaetocnema minuta | 1 |
| Chaetocnema sp | 20 |
| Dibolia borealis | 1 |
| Microrhopala vittata | 35 |
| Microrhopala xerene | 2 |
| Microrhopala sp | 43 |
| Coptocycla bicolor | 1 |
| Coptocycla plicata | 1 |
| Coptocycla sp | 4 |
| Chelymorpha argus | 16 |
| Tenebrionidæ (darkling beetles): | |
| Unidentified | 10 |
| Tenebrio obscurus | 1 |
| Opatrinus notus | 106 |
| Blapstinus moestus | 1 |
| Blapstinus metallicus | 1 |
| Blapstinus sp | 31 |
| Helops aereus | 1 |
| Anthicidæ (antlike flower beetles): | |
| Unidentified | 1 |
| Meloidæ (blister beetles): | |
| Unidentified | 2 |
| Meloë americanus | 1 |
| Epicauta pennsylvanica | 1 |
| RHYNCHOPHORA (Weevils): | |
| Anthribidæ (fungus weevils): | |
| Euparius marmoreus | 1 |
| Curculionidæ (curculios, or weevils): | |
| Unidentified | 267 |
| Epicaerus imbricatus | 2 |
| Phyxelis rigidus | 93 |
| Otiorhynchus sulcatus | 8 |
| Otiorhynchus ovatus | 61 |
| Otiorhynchus sp | 2 |
| Tanymecus confertus | 5 |
| Barypithes pellucidus | 1 |
| Sitona hispidula | 510 |
| Sitona flavescens | 34 |
| Sitona sp | 98 |
| Hypera punctata | 1244 |
| Phytonomus meles | 3 |
| Phytonomus nigrirostris | 75 |
| Phytonomus sp | 43 |
| Listronotus inaequalipennis | 1 |
| Listronotus frontalis | 1 |
| Listronotus sp | 1 |
| Hyperodes sp | 37 |
| Pachylobius picivorus | 1 |
| Lixus sp | 2 |
| Smicronyx corniculatus | 1 |
| Bagous sp | |

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

ANIMAL MATTER—Continued.

| RHYNCHOPHORA—Continued. | |
|---|---|
| Curculionidæ—Continued. | |
| Conotrachelus sp | 1 |
| Acalles sp | 1 |
| Tyloderma foveolatum | 2 |
| Tyloderma aerea | 4 |
| Tyloderma sp | 2 |
| Cryptorhynchus obliquus | 1 |
| Cryptorhynchus fallax | 1 |
| Cryptorhynchus tristis | 1 |
| Cryptorhynchus sp | 1 |
| Ceutorhynchus sp | 1 |
| Rhinoncus pyrrhopus | 19 |
| Rhinoncus longulus | 1 |
| Rhinoncus sp | 4 |
| Sphenophorus inaequalis | 5 |
| Sphenophorus pertinax | 1 |
| Sphenophorus costipennis | 1 |
| Sphenophorus melanocephalus | 1 |
| Sphenophorus parvulus | 110 |
| Sphenophorus zeae | 26 |
| Sphenophorus sp | 117 |
| HYMENOPTERA (ANTS, BEES, AND WASPS.) | |
| Unidentified hymenopterans | 172 |
| Hymenopterous cocoons | 4 |
| Tenthredinoidea (sawflies): | |
| Unidentified adults | 1 |
| Unidentified larvæ | 4 |
| Arge dulciaria | 1 |
| Schizocerus zabriskiei | 1 |
| Xiphydria maculata | 1 |
| Ichneumonoidea (parasitic wasps): | |
| Unidentified | 9 |
| Braconid (unidentified) | 1 |
| Apanteles forbesi | 1 |
| Meteorus sp | 1 |
| Chelonella sp | 1 |
| Aleiodes intermedius | 1 |
| Aleiodes sp | 2 |
| Capitonius sp | 1 |
| Cymodusa distincta | 3 |
| Paniscus geminatus | 1 |
| Therion morio | 1 |
| Homoptropus sp | 1 |
| Scambus sp | 1 |
| Pimplidia pedalis | 1 |
| Pimplidia sp | 1 |
| Itoplectis conquisitor | 1 |
| Rhyssa sp | 1 |
| Arotes amoenus | 1 |
| Itamoplex limatus | 2 |
| Itamoplex sp | 5 |
| Gambrus sp | 1 |
| Phygadeuon sp | 3 |
| Hemiteles sp | 4 |
| Phaeogenes sp | 19 |
| Amblyteles sp | 1 |
| Cratichneumon sp | 24 |
| Pterocormus seminiger | 1 |
| Pterocormus sp | 19 |
| Pseudamblyteles suturalis | 1 |
| Pseudamblyteles sp | 1 |

| HYMENOPTERA—Continued. | |
|---|---|
| Cynipoidea (gallflies): | |
| Figites sp | 3 |
| Formicoidea (ants): | |
| Unidentified | 374 |
| Crematogaster lineolata | 2 |
| Aphaenogaster mariæ | 1 |
| Aphaenogaster fulva subsp | 11 |
| Aphaenogaster fulva aquia | 4 |
| Aphaenogaster sp | 44 |
| Myrmica punctiventris | 1 |
| Myrmica rubra scabrinodis | 115 |
| Myrmica sp | 45 |
| Lasius niger americanus | 12 |
| Lasius niger neoniger | 2 |
| Lasius umbratus mixtus | 2 |
| Lasius umbratus mixtus aphidicola | 2 |
| Lasius claviger | 2 |
| Lasius latipes | 1 |
| Lasius sp | 11 |
| Formica truncicola integra | 1 |
| Formica pallide-fulva | 4 |
| Formica pallide-fulva var. schaufussi | 37 |
| Formica fusca subsericea | 62 |
| Formica sp | 39 |
| Camponotus herculeanus pennsylvanicus | 34 |
| Camponotus sp | 27 |
| Chrysidoidea (cuckoo wasps): | |
| Chrysis caerulans | 1 |
| Holopyga sp | 2 |
| Vespoidea (wasps): | |
| Unidentified | 2 |
| Gonatopus sp | 1 |
| Tiphia walleni | 1 |
| Tiphia inornata | 2 |
| Tiphia egregia | 1 |
| Tiphia transversa | 1 |
| Tiphia sp | 22 |
| Mutillid | 1 |
| Psammochares sp | 1 |
| Odynerus sp | 1 |
| Vespula maculata | 1 |
| Vespula vulgaris | 2 |
| Vespula marginata | 1 |
| Polistes pallipes | 4 |
| Sphecoidea (wasps): | |
| Didineis texana | 1 |
| Cerceris sp | 2 |
| Halictus lerouxi | 2 |
| Halictus sp | 1 |
| Chloralictus pilosus | 4 |
| Chloralictus zephyrus | 2 |
| Chloralictus obscurus | 1 |
| Chloralictus sp | 13 |
| Augochlora confusa | 1 |
| Augochlora sp | 1 |
| Sphecodes sp | 1 |
| Ptilandrena krigiana | 1 |
| Andrena brunniventris rhodura | 3 |
| Andrena forbesi | 1 |
| Andrena frigida | 1 |
| Andrena sp | 4 |
| Osmia sp | 1 |

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

ANIMAL MATTER—Continued.

| HEMIPTERA (TRUE BUGS). | |
|---|---|
| Unidentified bugs | 92 |
| Cydnidæ (negro bugs): | |
| Thyreocoris ater | 1 |
| Thyreocoris unicolor | 1 |
| Thyreocoris sp. | 8 |
| Amnestus spinifrons | 2 |
| Pentatomidæ (stinkbugs): | |
| Unidentified | 320 |
| Podops cinctipes | 1 |
| Brochymena sp. | 3 |
| Mormidea lugens | 1 |
| Euschistus servus | 1 |
| Euschistus euschistoides | 1 |
| Euschistus variolarius | 7 |
| Euschistus sp. | 9 |
| Cœnus delius | 32 |
| Thyanta custator | 1 |
| Acrosternum hilaris | 1 |
| Stiretrus anchorago | 1 |
| Mineus strigipes | 1 |
| Podisus maculiventris | 1 |
| Coreidæ (squash bugs): | |
| Unidentified | 3 |
| Anasa tristis | 1 |
| Anasa repetita | 1 |
| Alydus eurinus | 3 |
| Alydus sp. | 2 |
| Lygæidæ (chinchbugs): | |
| Unidentified | 39 |
| Blissus leucopterus | 5 |
| Isthmocoris piceus | 12 |
| Isthmocoris sp. | 2 |
| Phlegyas sp. | 2 |
| Myodocha serripes | 9 |
| Ligyrocoris sp. | 1 |
| Perigenes sp. | 1 |
| Cryphula parallelogramma | 1 |
| Reduviidæ (assassin bugs): | |
| Unidentified | 16 |
| Melanolestes picipes | 2 |
| Melanolestes sp. | 1 |
| Acholla multispinosa | 2 |
| Sinea diadema | 6 |
| Sinea sp. | 4 |
| Nabidæ (damsel bugs): | |
| Unidentified | 14 |
| Pagasa fusca | 8 |
| Nabis subcoleoptratus | 1 |
| Nabis sp. | 11 |
| Cimicidæ (bedbugs): | |
| Cimex sp. | 1 |
| Miridæ (leaf bugs): | |
| Miris dolobratus | 2 |
| Lygus pratensis | 7 |
| Lygus sp. | 2 |
| Neoborus sp. | 1 |
| Cicadidæ (cicadas): | |
| Tibicen sp. | 1 |

| HEMIPTERA—Continued. | |
|---|---|
| Cercopidæ (spittle insects): | |
| Philænus sp. | 1 |
| Membracidæ (tree hoppers): | |
| Ceresa diceros | 1 |
| Ceresa sp. | 1 |
| Campylenchia latipes | 3 |
| Cicadellidæ (leaf hoppers): | |
| Unidentified | 56 |
| Agallia 4-punctata | 1 |
| Agallia sanguinolenta | 2 |
| Agallia sp. | 1 |
| Draeculacephala mollipes | 1 |
| Gypona sp. | 1 |
| Xerophlœa viridis | 1 |
| Acucephalus albifrons | 9 |
| Deltocephalus sp. | 2 |
| Fulgoridæ (lanternflies): | |
| Unidentified | 2 |
| Scolops sp. | 4 |
| Acanalonia bivittata | 1 |
| ORTHOPTERA (GRASSHOPPERS, LOCUSTS, CRICKETS, (ETC.). | |
| Unidentified adults | 16 |
| Unidentified eggs | 10 |
| Forficulidæ (earwigs): | |
| Unidentified | 1 |
| Acrididæ (short-horned grasshoppers): | |
| Unidentified | 760 |
| Nomotettix cristatus | 2 |
| Nomotettix sp. | 1 |
| Tettix arenosus | 1 |
| Tettigidea parvipennis | 1 |
| Tettigidea lateralis | 1 |
| Tettigidea lateralis var. polymorpha | 1 |
| Tettigidea sp. | 8 |
| Orphulella olivacea | 1 |
| Stenobothrus curtipennis | 1 |
| Arphia sulphurea | 1 |
| Arphia xanthoptera | 1 |
| Chortophaga viridifasciata | 3 |
| Hippiscus sp. | 1 |
| Melanoplus femoratus | 2 |
| Melanoplus femur-rubrum | 24 |
| Melanoplus atlanis | 1 |
| Melanoplus sp. | 36 |
| Locustidæ (green grasshoppers): | |
| Unidentified | 84 |
| Orchelimum sp. | 2 |
| Conocephalus sp. | 4 |
| Gryllidæ (crickets): | |
| Unidentified | 332 |
| Gryllotalpa borealis | 1 |
| Nemobius fasciatus vittatus | 2 |
| Nemobius sp. | 312 |
| Gryllus pennsylvanicus | 4 |
| Gryllus sp. | 223 |
| Miogryllus sp. | 2 |

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

## ANIMAL MATTER—Continued.

| | |
|---|---|
| **LEPIDOPTERA (MOTHS, BUTTERFLIES, CATERPILLARS, ETC.).** | |
| Unidentified | 65 |
| Unidentified eggs | 1 |
| Unidentified caterpillars | 812 |
| Unidentified pupæ | 20 |
| Nymphalidæ (brush-footed butterflies): | |
| Argynnis cybele (caterpillar) | 1 |
| Arctiidæ (tiger moths): | |
| Unidentified caterpillar | 1 |
| Noctuidæ (cutworms): | |
| Unidentified caterpillars | 24 |
| Nephelodes violans (caterpillar) | 1 |
| Nephelodes minians (caterpillars) | 22 |
| Cucullia asteroides (caterpillars) | 2 |
| Lasiocampidæ (tent caterpillars): | |
| Malacosoma americana (caterpillars) | 3 |
| Malacosoma sp. (caterpillars) | 2 |
| Deilephila lineata (caterpillar) | 1 |
| **DIPTERA (FLIES AND THEIR MAGGOTS).** | |
| Proctacanthus sp | 1 |
| Sarcophaga sp | 1 |
| Phormia terræ-novæ | 1 |
| Musca domestica | 2 |
| Tipula sp | 1 |
| Chrysops sp | 1 |
| Leia sp | 1 |
| **ARACHNIDA (SPIDERS, TICKS, ETC.).** | |
| Drassus neglectus | 1 |
| Pachygnatha sp | 1 |
| Tetragnatha sp | 1 |
| Xysticus luctans | 1 |
| Lycosa carolinensis | 1 |
| Lycosa helluo | 1 |
| Lycosa punctulata | 1 |
| **MYRIAPODA (CENTIPEDES AND MILLIPEDS).** | |
| Diplopoda (millipeds): | |
| Unidentified | 913 |
| Nemasoma minutum | 1 |
| Julus cæruleocinctus | 10 |
| Chilopoda (centipedes): | |
| Unidentified centipedes | 7 |
| **CRUSTACEA (CRUSTACEANS).** | |
| Isopoda (wood lice, etc.): | |
| Unidentified | 15 |
| Orchestia grillus | 1 |
| Orchestia sp | 1 |
| Porcellio lævis | 2 |
| Porcellio sp | 1 |
| Armadillidium sp | 1 |
| **MOLLUSCA (SNAILS, ETC.).** | |
| Unidentified mollusks | 71 |
| Nassidæ (basket shells): | |
| Ilyanassa obsoleta | 2 |
| Zonitidæ (glassy snails): | |
| Zonites arboreus | 5 |
| Gastrodonta suppressa | 1 |
| Testacellidæ (flesh-eating land snails): | |
| Cochlicopa lubrica | 1 |
| Helicidæ (land snails): | |
| Vallonia sp | 11 |
| Auriculidæ (ear snails): | |
| Melampus lineatus | 28 |
| Littorinidæ (periwinkles): | |
| Littorina rudis | 5 |
| Pupillidæ (chrysalis shells): | |
| Vertigo ovata | 1 |

## VEGETABLE MATTER.

| | |
|---|---|
| Unidentified buds | 2 |
| Unidentified mast | 15 |
| Unidentified wild fruit | 184 |
| Vegetable garbage | 528 |
| Vegetable rubbish | 21 |
| Pinaceæ: | |
| Juniperus virginiana (red cedar) | 13 |
| Juniperus sp. (juniper) | 1 |
| Gramineæ: | |
| Unidentified grass seeds | 39 |
| Andropogon sorghum (sorghum) | 2 |
| Panicum miliaceum (millet) | 1 |
| Panicum sp. (switchgrass) | 6 |
| Chætochloa glauca (foxtail) | 11 |
| Chætochloa sp. (foxtail) | 13 |
| Eragrostis sp. (love grass) | 1 |
| Anthoxanthum odoratum (sweet vernal grass) | 1 |
| Zea mays (corn) | 59 |
| Triticum vulgare (wheat) | 15 |
| Avena sativa (oats) | 6 |
| Cyperaceæ: | |
| Unidentified sedge | 4 |
| Carex sp. (sedge) | 6 |
| Convallariaceæ: | |
| Asparagus officinalis (asparagus) | 1 |
| Smilaceæ: | |
| Smilax herbacea (carrion flower) | 1 |
| Smilax sp. (greenbriar) | 1 |
| Myricaceæ: | |
| Myrica carolinensis (bayberry) | 122 |
| Betulaceæ: | |
| Alnus sp. (alder) | 1 |
| Ulmaceæ: | |
| Celtis occidentalis (hackberry) | 9 |
| Moraceæ: | |
| Morus alba (white mulberry) | 45 |
| Morus rubra (red mulberry) | 52 |
| Morus sp. (mulberry) | 76 |
| Polygonaceæ: | |
| Rumex sp. (dock) | 8 |
| Polygonum lapathifolium (smartweed) | 1 |

TABLE IV.—*List of items identified in the food contained in 2,626 starling stomachs examined, and the number of stomachs in which each was found*—Continued.

VEGETABLE MATTER—Continued.

| | |
|---|---|
| Polygonaceæ—Continued. | |
| Polygonum pennsylvanicum (smartweed) | 2 |
| Polygonum persicaria (smartweed) | 1 |
| Polygonum sp. (smartweed) | 12 |
| Chenopodiaceæ: | |
| Chenopodium sp. (pigweed) | 1 |
| Amaranthaceæ: | |
| Amaranthus sp. (amaranth) | 1 |
| Aizoaceæ: | |
| Mollugo verticillata (Indian chickweed) | 1 |
| Phytolaccaceæ: | |
| Phytolacca decandra (pokeweed) | 20 |
| Caryophyllaceæ: | |
| Silene media (chickweed) | 2 |
| Berberidaceæ: | |
| Berberis vulgaris (barberry) | 1 |
| Berberis sp. (barberry) | 3 |
| Lauraceæ: | |
| Sassafras sassafras (sassafras) | 3 |
| Brassicaceæ: | |
| Brassica sp. (mustard) | 1 |
| Grossulariaceæ: | |
| Ribes sp. (currant) | 1 |
| Rosaceæ: | |
| Fragaria sp. (strawberry) | 8 |
| Rubus sp. (blackberry) | 27 |
| Malaceæ: | |
| Sorbus sp. (mountain ash) | 1 |
| Amelanchier sp. (June berry) | 2 |
| Malus sp. (cultivated apple) | 45 |
| Pyrus sp. (cultivated pear) | 3 |
| Amygdalaceæ: | |
| Prunus serotina (wild black cherry) | 207 |
| Prunus virginiana (chokecherry) | 18 |
| Prunus maritima (beach plum) | 1 |
| Prunus sp. (cultivated cherry) | 469 |
| Prunus sp. (wild cherry) | 62 |
| Cassiaceæ: | |
| Gleditsia triacanthos (honey locust) | 1 |
| Fabaceæ: | |
| Trifolium sp. (clover) | 3 |
| Robinia pseudacacia (locust) | 2 |
| Anacardiaceæ: | |
| Rhus glabra (smooth sumac) | 32 |
| Rhus copallina (dwarf sumac) | 1 |
| Rhus radicans (poison ivy) | 89 |
| Rhus vernix (poison oak) | 1 |
| Rhus sp. (sumac) | 266 |
| Aquifoliaceæ: | |
| Ilex verticillata (black alder) | 2 |
| Celastraceæ: | |
| Celastrus scandens (bittersweet) | 4 |
| Vitaceæ: | |
| Psedera quinquefolia (Virginia creeper) | 39 |
| Ampelopsis sp. (?) (ampelopsis) | 2 |
| Vitis sp. (grape) | 26 |
| Cornaceæ: | |
| Cornus florida (flowering dogwood) | 4 |
| Cornus amomum (kinnikinnik) | 1 |
| Cornus asperifolia (rough-leaved dogwood) | 1 |
| Cornus paniculata (panicled dogwood) | 1 |
| Cornus sp. (dogwood) | 3 |
| Nyssa sylvatica (sour gum) | 44 |
| Ericaceæ: | |
| Gaylussacia frondosa (huckleberry) | 1 |
| Gaylussacia baccata (huckleberry) | 3 |
| Gaylussacia sp. (huckleberry) | 3 |
| Vaccinium sp. (blueberry) | 5 |
| Solanaceæ: | |
| Solanum sp. (nightshade) | 4 |
| Plantaginaceæ: | |
| Plantago lanceolata (ribgrass) | 1 |
| Plantago sp. (plantain) | 5 |
| Caprifoliaceæ: | |
| Viburnum sp. (arrowwood) | 19 |
| Sambucus canadensis (elder) | 148 |
| Compositæ: | |
| Ambrosia artemisiifolia (ragweed) | 29 |
| Taraxacum taraxacum (dandelion) | 4 |

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